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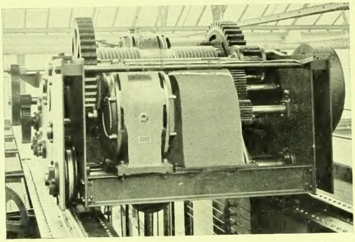

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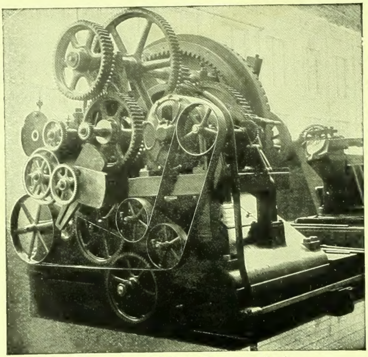

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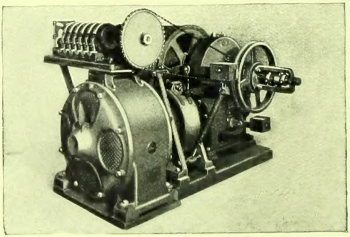

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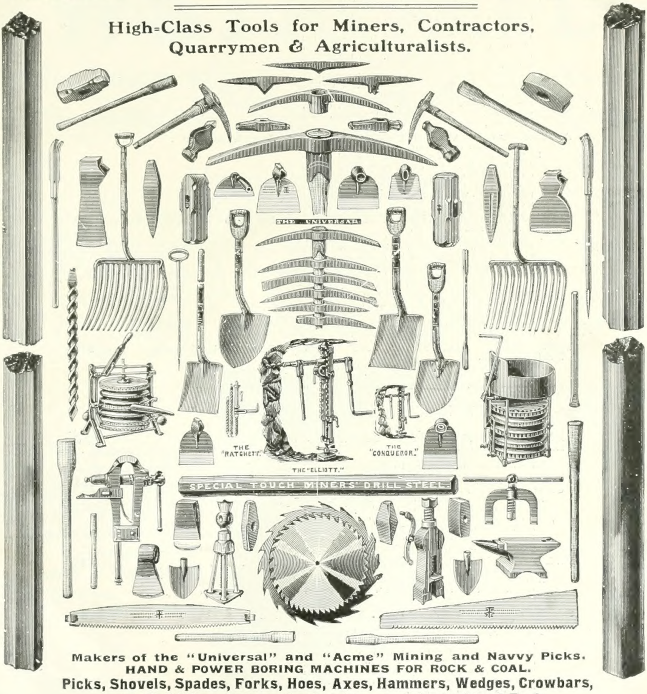
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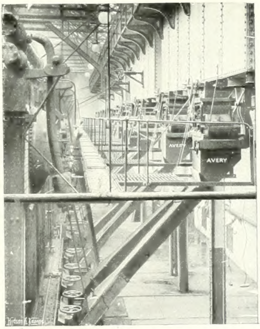

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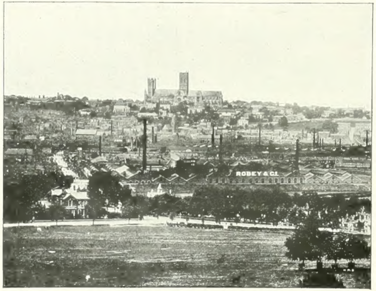

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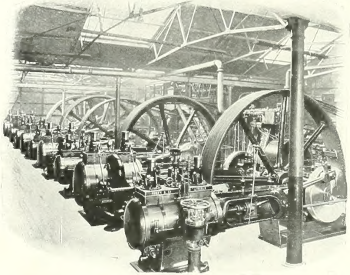

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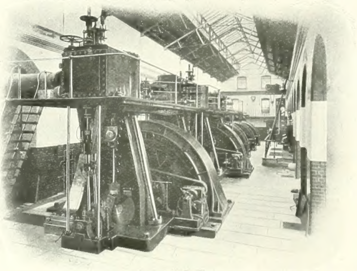

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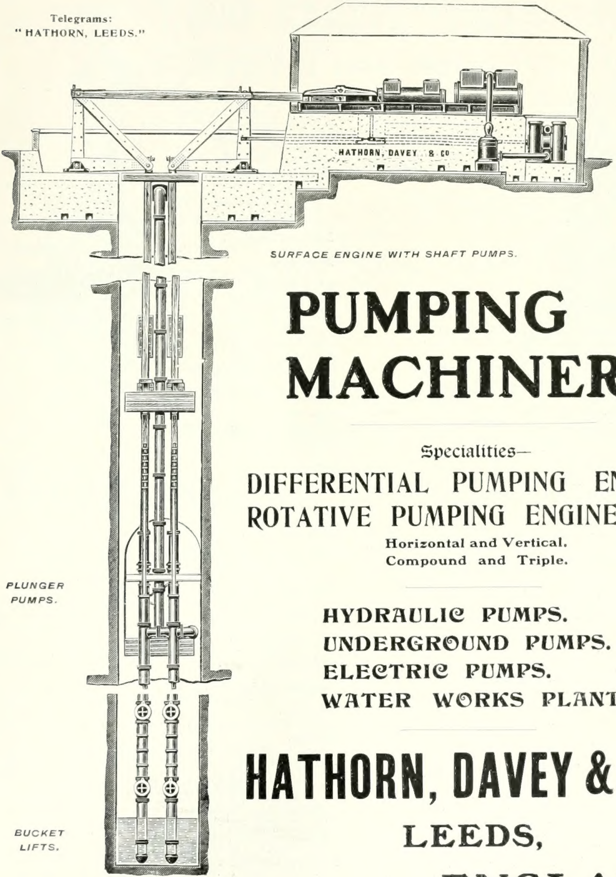

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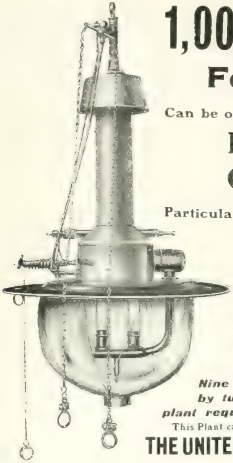

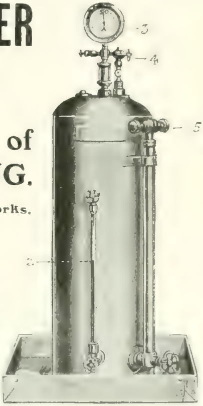

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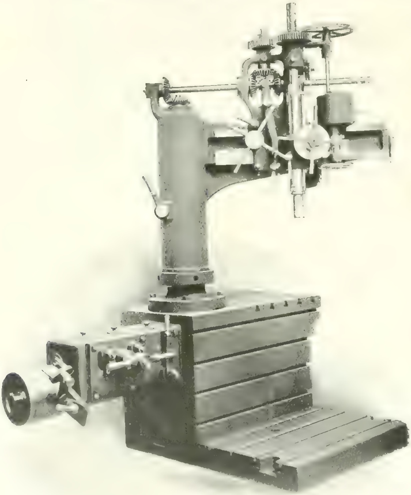

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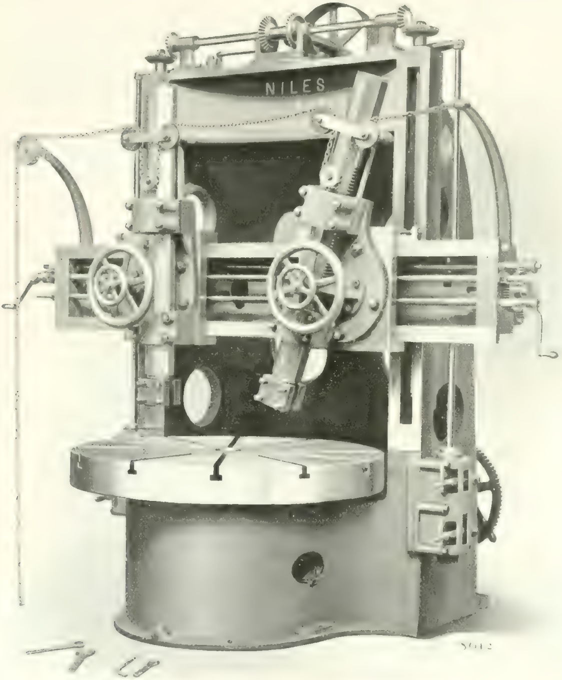

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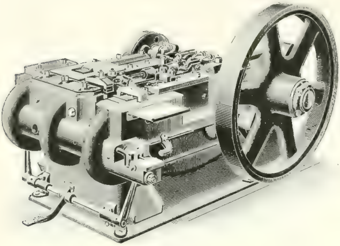

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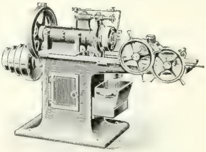

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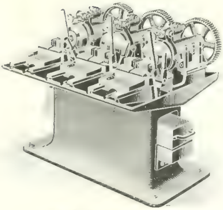

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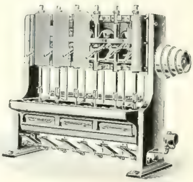

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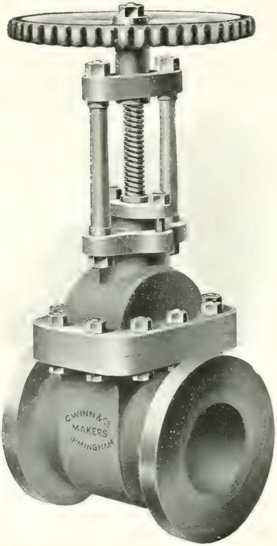

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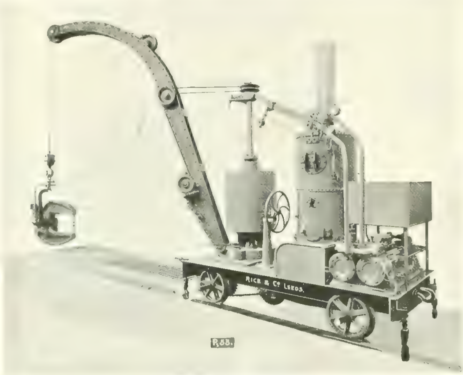

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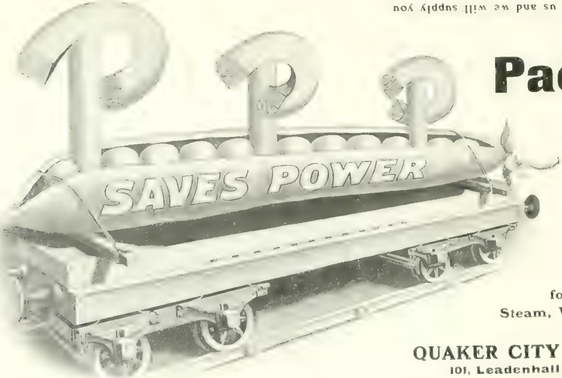

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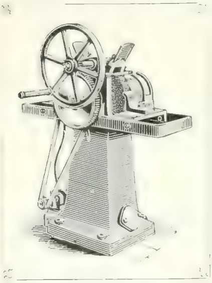

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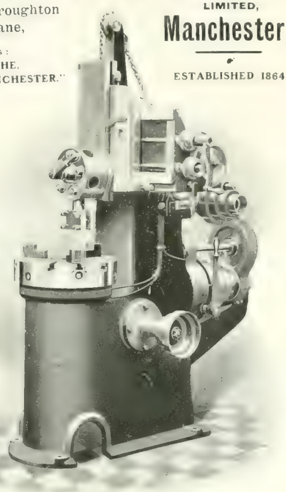

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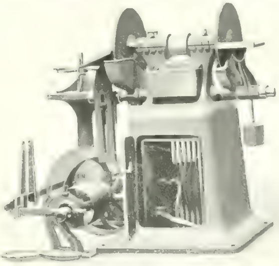

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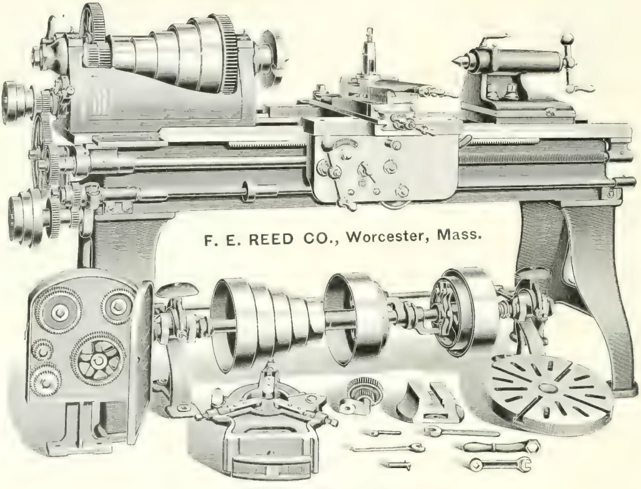
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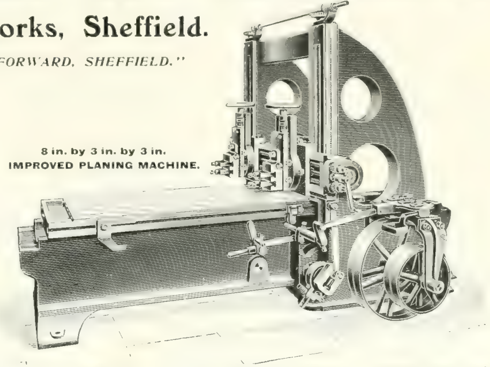

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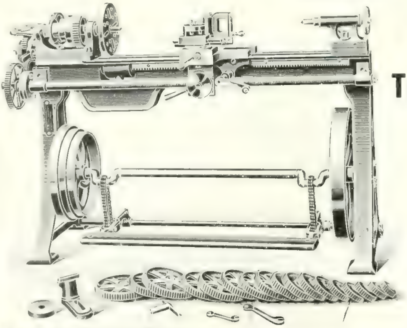

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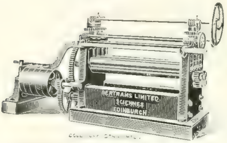

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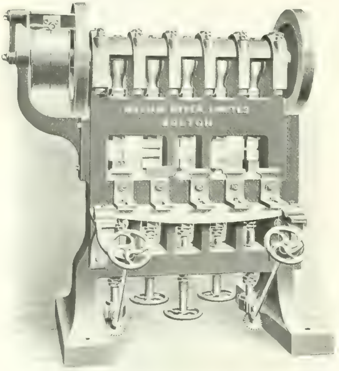

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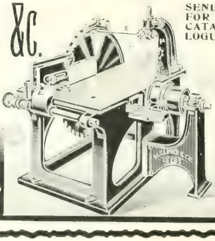

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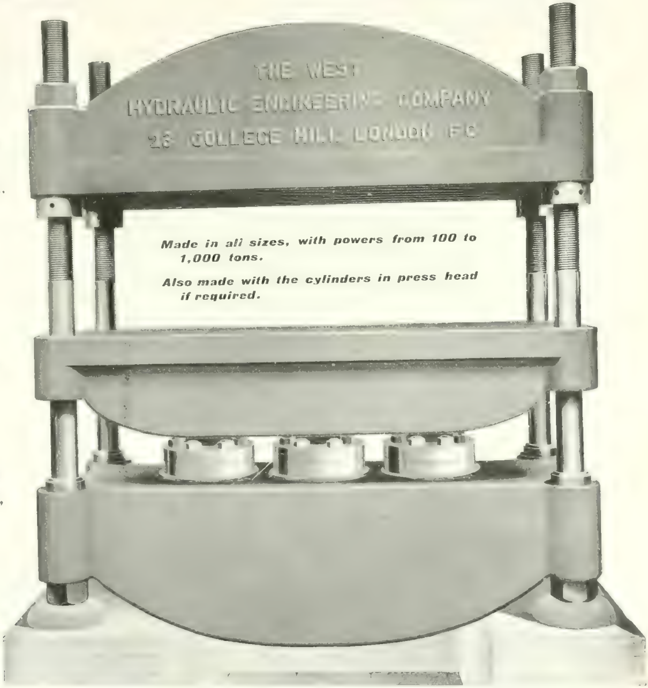

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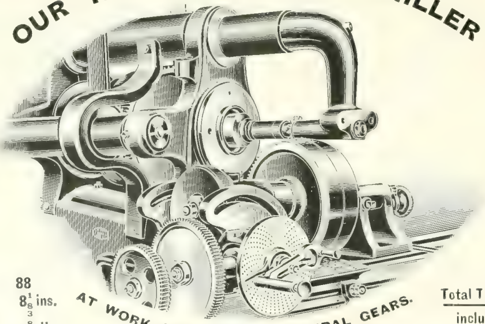

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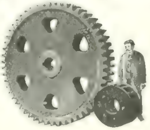

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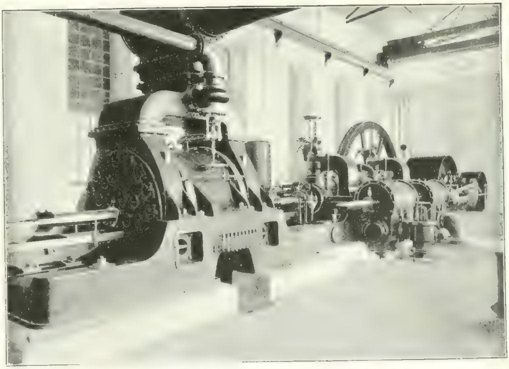

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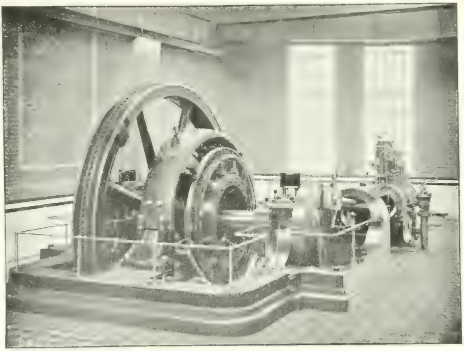

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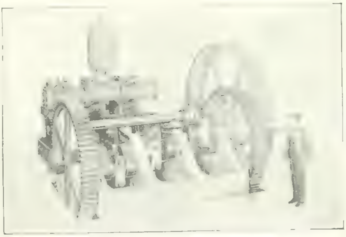

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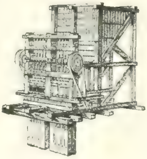

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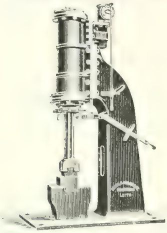

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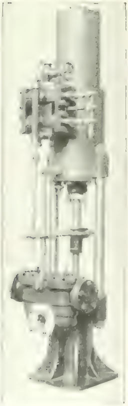

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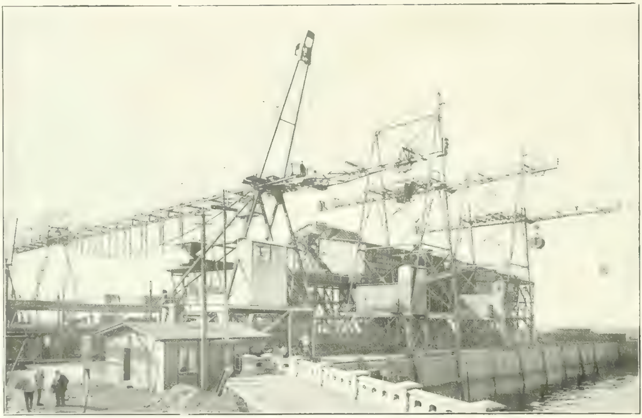

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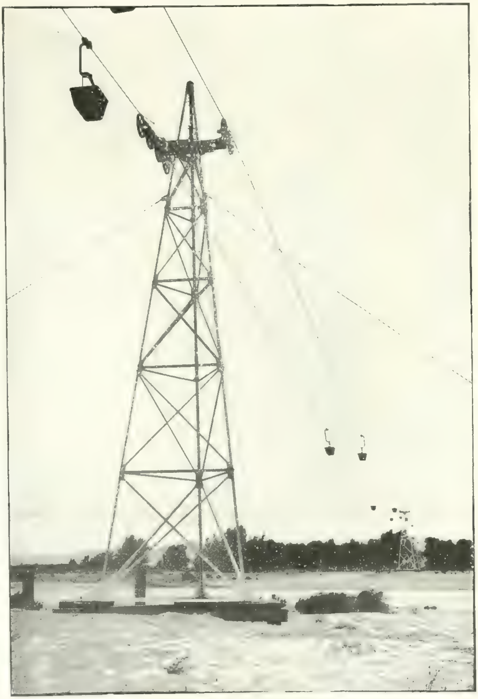

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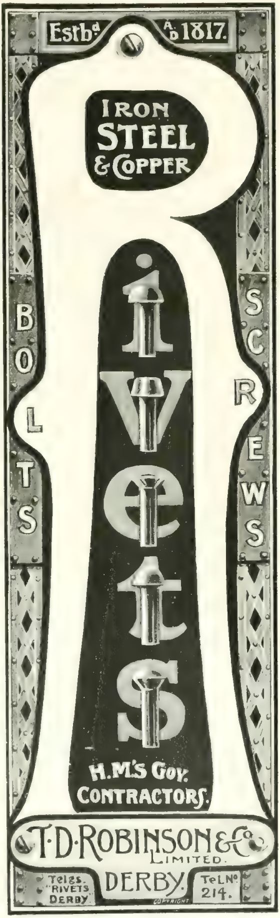

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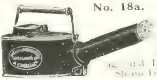

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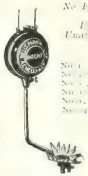

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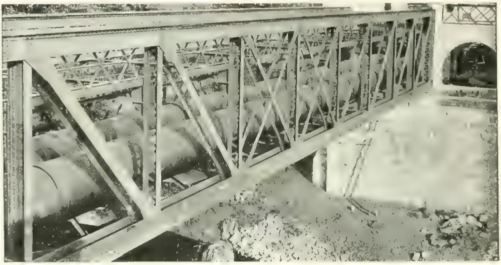

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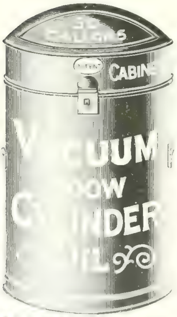

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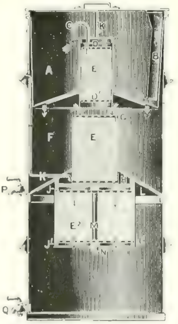

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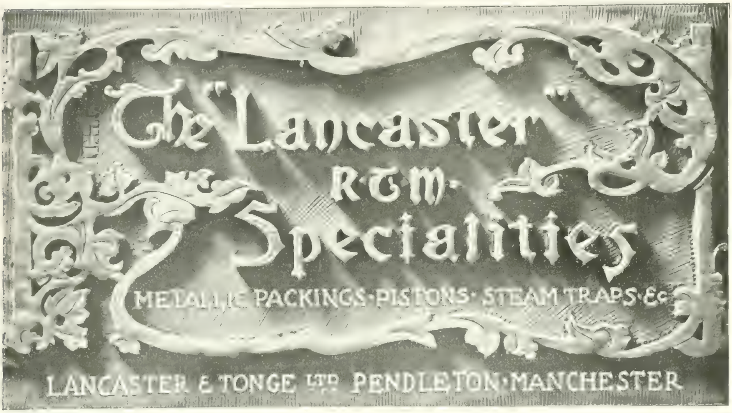

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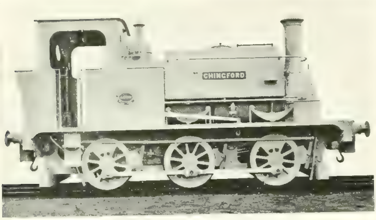

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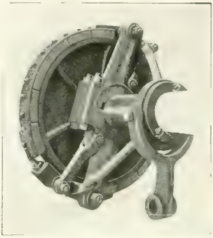

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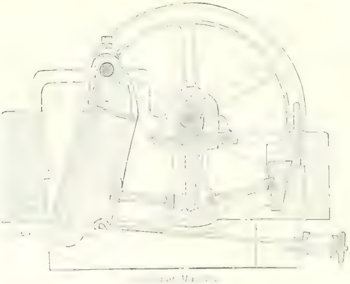

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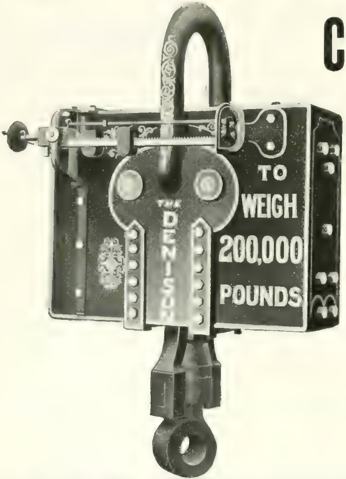

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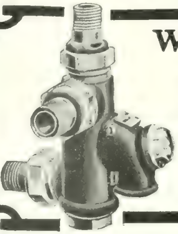

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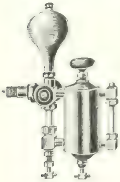

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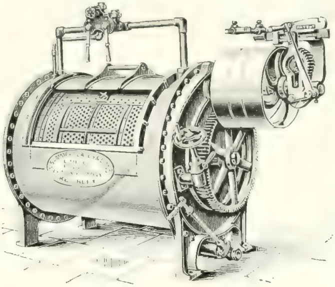

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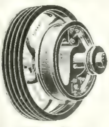

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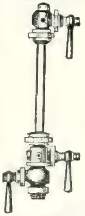

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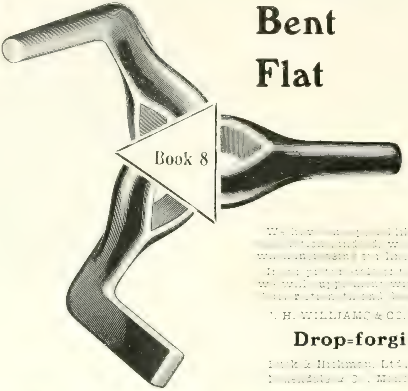

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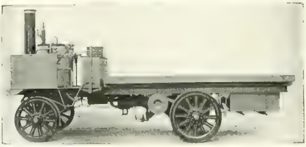

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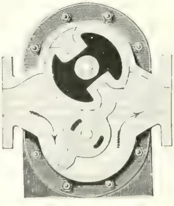

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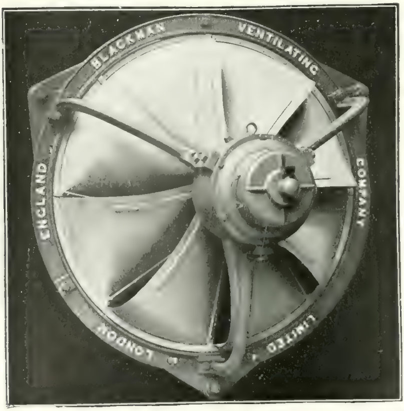

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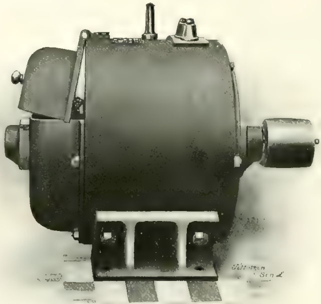

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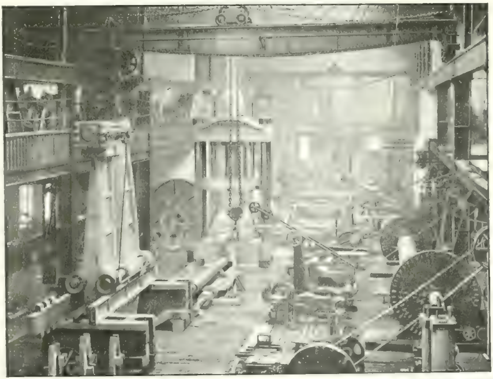

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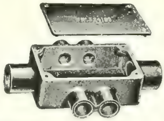

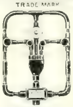

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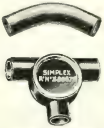

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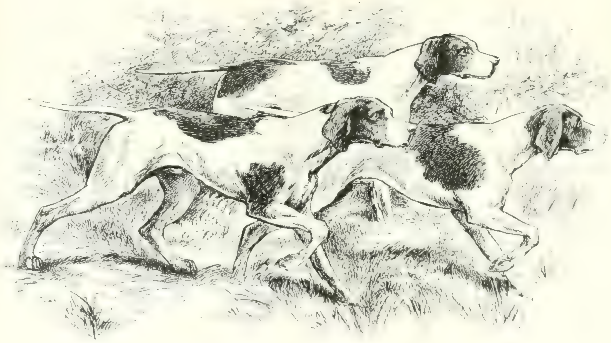

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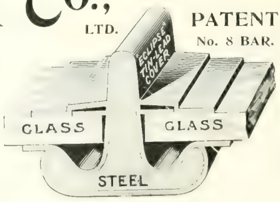

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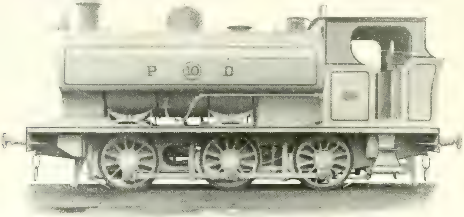

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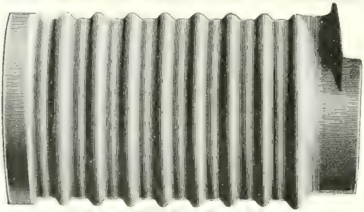

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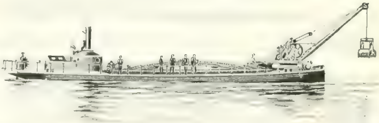

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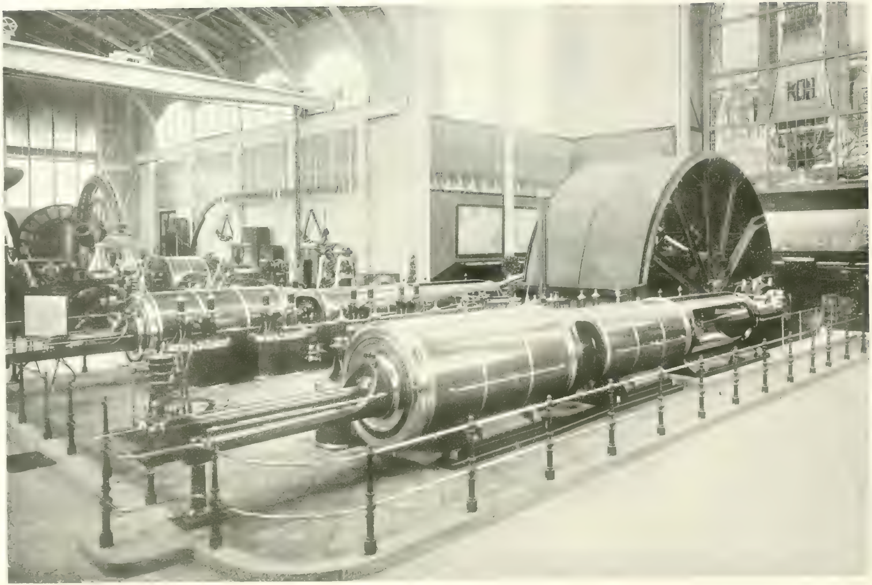

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An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

VOL. III. LONDON, DECEMBER, 1903. NO. 6.

NOTES ON THE WESTPHALIAN COAL FIELD.

BY

DAVID A. LOUIS.

Mr. Louis recently made an extensive tour of the Westphalian district, and the notes which are embodied in the present series of articles were therefore obtained first-hand. After a brief description of the geology of the district, the author plunges at once into the most recent phases of Westphalian practice. In the present article he describes the various methods of working the coal and the most recent systems of transport. In future articles attention will be given to winding systems, the pumping arrangements employed in the mines, gas, temperature, ventilation, lamps, explosions, output, screening and washing, coke, briquettes, labour, cost, housing, etc.—ED.

I.

THE importance of the Rheno-Westphalian coal field is so universally acknowledged that no apology is necessary in drawing attention to some matters connected with that progressive industrial district. The yearly output of the Rheno-Westphalian coal field approaches sixty million tons of coal. In 1900, when a maximum production had been attained, there were 210 collieries and 167 winding plants. Of these collieries, 138 produced more than 50,000 tons, 45 more than 500,000 tons, and one—Zollverein, nearly 1,753,000 tons. This coal field is situated mainly in the Prussian Province of Westphalia, but spreads across the Rhein, to some extent, at Homburg, opposite Ruhrort. The mines are mostly situated about the valleys of the Ruhr and Emscher, but as time advances, are stretching more and more into the valley of the Lippe, all these rivers are tributaries of the Rhine [illegible].

GEOLOGY.

Geologically, this field may be considered as an eastern extension of the great coal fields of the north of France, of Belgium, and of Aix-la-Chapelle. It consists of a series of contiguous basins resting on non-productive carboniferous beds, which form the southern boundary at the outcrop B (fig. 1), and these in turn abut on Devonian strata, as shown in the accompanying map and section.

At the outcrop it has an area of about 346 square miles, but it extends northwards under overlying younger formations to an extent as yet unknown. So far as the borings and workings indicate, the coal bearing area may be computed to cover 1,128 square miles, but a considerable portion of the covered field is as yet untouched. The explored overburden varies in thickness, attaining to 696, 1,644, and even 2,598 feet toward the present northern boundary. In 1870 half the output of the field was from mines working at the outcrop. In 1898 this proportion was reduced to 16 per cent., and it will become less and less as the new area gets opened out. The greatest thickness of the coal measures is 9,978 ft., and the thickness of the stone beds as compared with the coal-seams is as 40 to 1 in the flaming coal area, 30 to 1 in the gas-coal portions, 26½ to 1 in the fat bituminous seams, and 100 to 1 in the lean coal beds. The latter will probably be unworkable on account of their great depth in the northern part of the field, and therefore disregarding these, the thickness of the stone is thirty times that of the coal in the remaining productive measures.

There are some ninety workable seams which vary in thickness from 15½ to 45 feet. They all

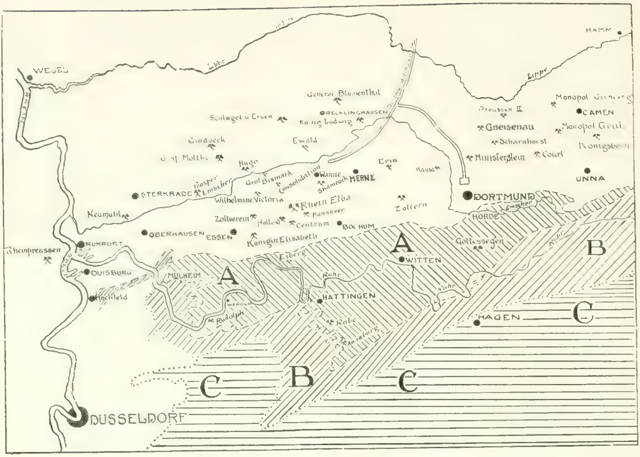


FIG. 1. SKETCH MAP OF THE RUHR DISTRICT.

A—Outcrop, productive carboniferous beds.
B— „ barren „ „
C „ Devonian rocks.

Collieries indicated by crossed hammers.

lie in more or less well-defined beds, but four or five are recognised as typical, and are developed to a varying extent in different parts of the field; each bed, as a rule, yields coal of a distinctive character. Following the order of super-position downward, they may be classed as flaming, gas, fat and bituminous, and lean coal, and typical seams of each in the order given are Bismarck, Zollverein, Laura, and Sonnenschein, and Mousegatt.

There is a considerable amount of faulting, and much variation in the thickness of the seams in general, and even of the same seam at different parts of the field. The thickness of the over-burden likewise varies as already noted, so that the field is not blessed with any special dispensation from difficulties in this direction. In fact, the overlying beds, extending as they do from Trias to Tertiarics, and recent deposits present considerable difficulties to shaft-sinking in the parts of the field affected, hence many interesting methods of overcoming these difficulties have been developed in this region, such as the Tomson, the Kind-Chaudron, the Pattberg, and sack-boring. The depths of the shafts, of course, vary with the thickness of the overburden, and are getting deeper and deeper towards the north part of the field. In Table A the depths of a few of the notable shafts are given :—

TABLE A.

Shaft.	Locality.	Depth in Fathoms.
Schlagel and Eisen	Recklingshausen	383
Wilhelmine	Schalke	388½
Rhein Elbe III.	Gelsenkirchen...	389½
Ewald	Herten	400
Monopol Grimberg ..	Camen	421½
General Blumenthal ..	E. Recklingshausen	400

WORKING.

As a rule, the shafts are circular, the usual diameter being 16½ ft., which, however, is greatly exceeded in some of the new shafts. With regard to the actual mining, many different

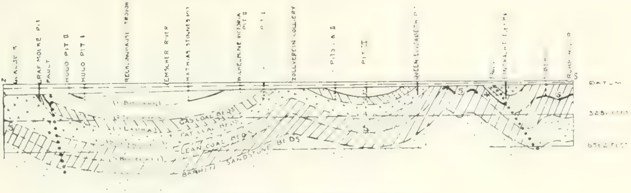


FIG. 2. SECTION ACROSS RUHR COAL FIELD.

modes of winning the coal are in use; in fact, methods are selected to suit the peculiarities and vagaries of the seams, and therefore in the workings at different mines a great diversity of systems are encountered; but, as a matter of fact, in some cases, even in the same mine various methods are adopted to suit the characters of the different seams or the varying character of the same seam.

The most striking feature about recent Westphalian practice is the replacement of "pillar and stall" methods, which had reigned supreme for nearly a century, by "longwall" methods with complete stowage of the workings. The chief reasons for this are: the prevention or else the considerable abatement of the destruction of the surface by subsidence; the greater security in working contiguous seams; the easier ventilation; the greater yield of *round* coal; the prevention of underground fires; and the stoppage of sudden inflows of water in wet areas. The extra irksome factors entailed by the new practice are procuring the material for stowage and its distribution in the mines. Few mines provide sufficient waste in working for complete stowage, therefore all sources are drawn on; many a great spoil heap has already *in this way found its way—or is on its way*—back into the mine; any sort of rocky waste or cinders or clinker, but particularly granulated blast furnace slag and the waste rock from the coal washeries, are sought after; failing these sources, rock is quarried on the surface and taken underground. Therefore longwall, with wide stalls, is in vogue, with flat or slightly inclined seams, which yield material for packing; whilst stepped longwall is used in slightly inclined seams. For the more inclined and larger seams a modified stepped longwall is adopted, in which the coal is removed in a series of lifts generally in steplike fashion; the stepping in some cases being inverted. Thin steep seams are worked to the rise by the inverted stepped system, similar

FIG. 3. PREUSSEN COLLIERY, SHOWING SHAFT HOUSE.

to over-hand stoping in metal mining. These methods are varied to suit circumstances; there is, too, still a moderate amount of pillar and stall work done where considerable difficulties would be encountered in making an alteration. The problem of bringing the stowage material into and distributing it in the mines has given rise to much ingenuity in devising schemes that shall not interfere with the outward movements of the coal, but it would be out of place to go into such detail here; suffice it to say that in newer collieries frequently a supplementary winding plant is installed for dealing with this material, and roads are kept open for it, whilst staple shafts with pulleys are specially provided for conveying it to where it is wanted at the working faces.

TRANSPORT.

The coal is taken from the working place in sheet iron tubs carrying half a ton. On inclined seams it is brought to the levels by self-acting inclined planes; on other seams in the usual way. From the levels to the shafts it is either drawn by horses or by mechanical haulage; the latter in the form of wire rope haulage is rapidly supplanting the former, of which only a few thousand still remain in use underground. Some roads are nearly three thousand yards long, and there are few less than eleven hundred.

Amongst the longest haulage roads are the following: Centrum, 2,943 yards; Königsborn, 2,746 yards; Holland, 2,464 yards; Ewald and some others, 2,100.

Steam and compressed air are used for the hauling engines; but electrical, especially three-phase machines, are being introduced into these collieries. With steam and compressed air, twin engines are used, the former with condensers. In the latter, air is heated in proximity to the admission valves of the engine with waste steam or coke fires, or mine gas or even with electricity; in the latter case by the use of a resistance spiral surrounding the tube leading to the engine; the spiral itself being protected by an outer casing.

WINDING.

The old massive masonry towers with timber pit frames, have almost all disappeared, and in all the new collieries the whole pithead structure is built of iron or steel, and one of the most characteristic features of the neighbourhood is the tall, slender pit frame generally of lattice girder work, and consisting of the guide frame supported by two or three inclined props.

Newer collieries, Preussen, Scharnhorst, etc., have what is known in the district as "English" frames; in these the weight of the pulley and load is taken by a special pair of legs supported by back legs in the usual manner, and the guide frame is relieved of this burden. Frames of this description are shown in figs. 3 and 4. These represent the exterior of Preussen I. Pit, and give a very slight idea of the kind of buildings that are put up at recent collieries in Westphalia.

(To be continued.)

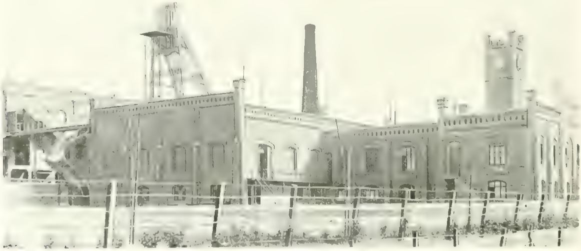
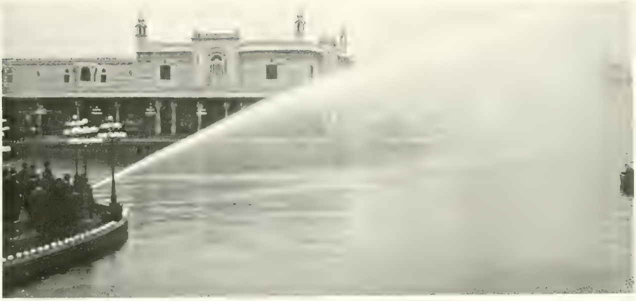


FIG. 4.—PREUSSEN COLLIERY, WINDING ENGINE BUILDINGS.



FIRE ENGINE TRIALS.

A 2½-in. jet being projected across the lake at Earl's Court, a distance of some 300 ft., by the large steam fire engine, constructed for the Cape Town Fire Brigade by Messrs. Shand, Mason and Co.

SOME MODERN FIRE APPLIANCES.

Illustrative of the International Fire Exhibition at Earl's Court, and à *propos* of the Fire Prevention Congress Report.

BY

GEORGE ARMISTEAD.

THE conclusion of the International Fire Exhibition at Earl's Court, and the issue of the official report of the first International Fire Prevention Congress* call for a brief review of progress in recent fire prevention and extinction.

There is an ever-increasing danger of fire in modern workshops and factories, which makes the subject one of extreme importance to manufacturers, and it is, therefore, a matter for congratulation that both these functions are likely to be followed by practical results.

The Congress was unique, too, as Mr. E. O. Sachs (Chairman of the British Fire Prevention Committee) points out in his introduction to the report, the world has never before seen a fire prevention congress, or a conference of those interested in measures for preventing the outbreak and spread of fire, as distinct from fire-extinguishing and life saving.

OBJECTS OF THE FIRE PREVENTION CONGRESS.

The task which the conveners set the Fire Prevention Congress is thus set forth in the report :—

It was to discuss :—

(*a*) The practice of building construction and the application of building materials from a fire prevention point of view ; comparing the practice in different countries, and inquiring into the latest materials and systems of construction available, as also the latest inventions for the general equipment of buildings.

(*b*) The equipment of buildings, particularly in relation to the application of electric power and electric light eliciting the views of electrical engineers and fire brigade officers as to the origin and prevention of electrical fires, including fires caused by lightning.

(*c*) The development of ordinary and automatic electrical fire alarm systems and their application.

(*d*) The legislative enactments in force in cities and districts, particularly in respect to the limitation of area or cubical contents for warehouse buildings and workshops, and the means of separating and uniting such buildings, also the means of escape in case of fire ; likewise the regulations governing the construction and control of theatres and places of public resort, and the means of escape in case of fire in shops and tenements.

(*e*) The best means of watching or inspecting buildings and plant exposed to fire risks without undue inconvenience to owners and occupiers, the practice of fire brigades in this direction, and the experience of the various fire patrol systems.

(*f*) The latest experience as to spontaneous ignition and safeguards for the storage of explosives and oils, the practice in respect to insurance against

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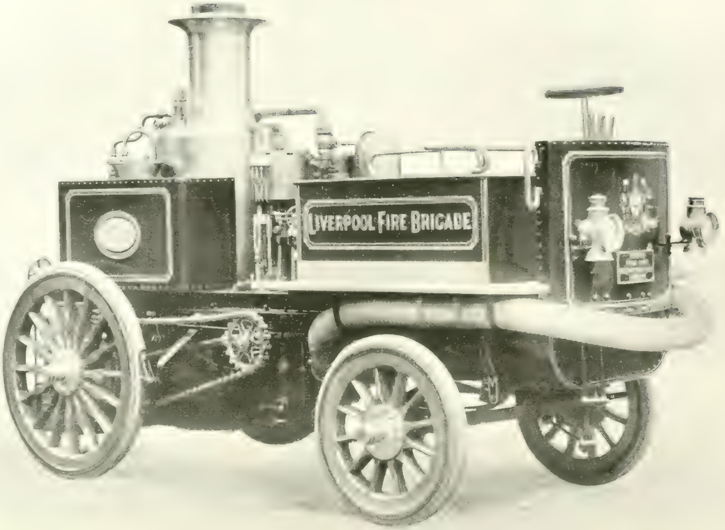
* Official report of the International Fire Prevention Congress convened by the executive of the British Fire Prevention Committee (founded 1897, incorporated 1899), [illegible] pages, illustrated, published for the British Fire Prevention Committee by the *Public Health Engineer*.



OIL FUEL MOTOR STEAM FIRE ENGINE, BUILT BY MESSRS. MERRYWEATHER AND SONS FOR THE LIVERPOOL FIRE BRIGADE.

fire; the systems adopted in various countries; the risks insured against; the relations of national, municipal, public, and private insurance corporations; systems of mutual insurance, the precautions taken against incendiarism, the statistical recording of fire losses, and the preparation of uniform fire maps and plans.

(*g*) The best means of recording the causes and effect of fires, and tabulating the results, so that a basis for comparison may be obtained, and standards compiled for various degrees of fire-resistance required in different buildings and suited for various materials; the best methods of testing materials and recording the facts of such tests for the information of those engaged in the construction, use and protection from fire of buildings.

ITS RESOLUTIONS.

The report calls attention to the list of resolutions passed by the various sections and confirmed by the Congress. A perusal of these shows that, "in certain branches of fire preventive work, definite conclusions of great importance were successfully formulated. Among these expressions of opinion by members of the Congress, perhaps the most notable is that which calls for the abolition of the term 'fire-proof' in relation to building construction. It is proposed to adopt in its place the more accurate term fire-resisting." Closely connected with this resolution and of almost equal importance is the suggestion that a classification of degrees of 'fire-resistance' should be universally adopted on the basis of a scheme drawn up by the British Fire Prevention Committee after a protracted series of investigations and experiments. It is to be hoped that these three resolutions will prove to be the first step towards banishing the misleading term 'fire-proof,' applied by manufacturers to their more or less resistant materials, in order to lure the unwary architect or builder into a false sense of satisfaction. As it is unlawful to sell margarine for butter, so it should be forbidden to sell as 'fire-proof' systems of construction which collapse at the mere semblance of a fire.

At the same time, the admiration of the Continental members for the work and methods of the British Fire Prevention Committee found expression in the desire for an establishment of testing stations on the model of that in Bayswater, in all countries under the guidance of an International Committee. The Congress was also of opinion that the building laws in most countries require revision to make them accord with the most recent experience with fire-resisting materials. The necessity for bringing legislation up to date from time to time is obvious, but recent experience has shown that any such attempt in London will meet with much opposition from property owners. Nor will any such legislation prove effective which is not retrospective in character, and does not provide for capable official supervision.

The Congress considered both, on the one hand, that special courses of study dealing with fire prevention should be instituted in all architectural and engineering schools and colleges; as also, on the other, that every attempt should be made to popularise the subject by the formation of local branches to the existing fire prevention societies.

The neglect of preventive work by fire brigades also received notice, and a careful study of the question by fire brigade officers was strongly recommended.

Perhaps the most important resolution from a fireman's point of view was that calling for the due legislation of their position and their inspection by Government officials. A demand for systematic investigation of every fire by an official appointed for the purpose, who should make a report on the cause of the outbreak and all the circumstances connected therewith, was strongly supported; and the Press was reminded of the good work which might be done by an enterprising editor if he were to publish practical reports of fires, able to teach the general public the lessons to be learnt from many of the fires. In this connection an idea was thrown out that an international publication dealing with actual fires and their lessons would be of great value.

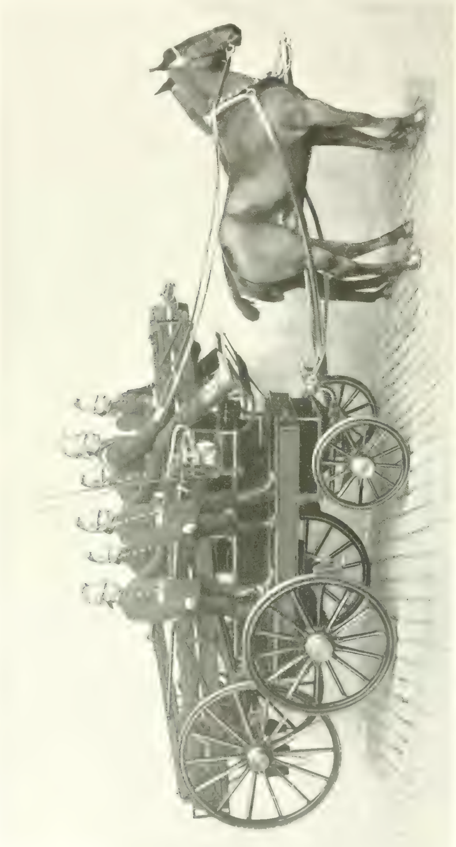
Finally, with a view to a complete union between the two branches of fire protection, the Congress advised the consolidation, in each country, of all regulations, whether for the prevention or the extinction of fire, into a single Fire Act, which should leave scope for additional by-laws to meet local requirements.

After hearing a series of valuable papers on fire insurance questions, the Congress passed two brief but weighty resolutions, on the one hand, condemning any system of fire insurance which did not discriminate between safe and unsafe construction, and on the other, emphatically endorsing the growing opinion in Europe that the American Factory Mutual Insurance system has proved invaluable as a preventive of fire and loss therefrom.

The most valuable achievement of the Congress might be summarised under three heads: (1) It has laid the basis for the foundation of an effective international policy for the prevention of fire, based upon a regular international exchange of experience and thought; (2) it has brought about an international understanding on the subject of requirements of and methods of testing 'fire-resistance' in building materials and systems; (3) it has assisted in breaking down the barrier between some of the personal and vested interests of fire prevention and fire extinction, and has brought together leading representatives of each of these branches with the happiest results."

THE EXHIBITION.

The idea of the Exhibition was the outcome of the interest aroused in fire matters during the year 1902, principally on account of the increasing loss of life from fire in the Metropolis and the controversies on the equipment of fire brigades and fire preventive building legislation. The initiative was taken by the British Fire Prevention Committee, who suggested to the Directors of the London Exhibition Company that their grounds at Earl's Court lent themselves to such an object. This proposition was accepted, and the International Fire Exhibition was accordingly organised by the British Fire Prevention Committee, supported by the National Fire Brigades Union, the Exhibition Company undertaking the business arrangements and the financial responsibility. H.R.H. the Duke of Cambridge accepted the Presidency, the Vice-Presidents being the Duke of Marlborough, the Lord Mayor of London, and Mr. Sachs, Chairman of the Executive of the British Fire Prevention Committee, whilst the influential Advisory Council comprised the presidents or leading members of the principal scientific and learned societies.

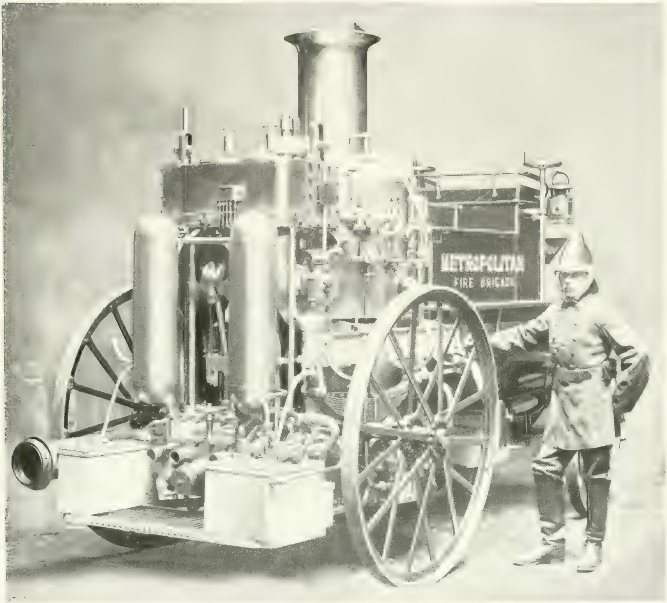


SHAND-MASON PATENT HORSE FIRE ESCAPE, COMBINED WITH HORSE CARRIAGE OR CHEMICAL ENGINE.

The opening ceremony was performed by the Duke of Cambridge on the 6th May, and attracted a brilliant assembly, which included many fire chiefs from the Continent. Exhibits both for the Commercial and Loan Sections quickly flowed in from Great Britain and the Continent, and ultimately a thoroughly representative collection of fire-preventive systems and fire appliances was secured. In the Loan Section was to be seen a series of old fire engines, apparatus, and engravings dating from before the Fire of London to our own times, and including a collection of relics of Van der Heyd, inventor of the fire engine. Equally instructive was the carefully prepared pageant in the Empress Theatre, showing the evolution of fire-fighting since the occupation of Great Britain by the Romans, and terminating with a remarkable display of modern engines and escapes actually at work on a burning building.

BRITISH FIRMS HOLD THEIR OWN.

In the Commercial Section many of the foreign makers of fire appliances exhibited apparatus with which English brigades were unacquainted, and one of the earliest results of the exhibition was the introduction of the "Pompier" escape in the London Brigade. The awards bestowed on exhibitors were the result of most careful deliberation on the



POWERFUL 1,000 GALLON STEAM FIRE ENGINE, BUILT BY MESSRS. SHAND, MASON AND CO. FOR THE METROPOLITAN FIRE BRIGADE, CAPE TOWN.

"Double Vertical" variable steam expansion type.

part of juries comprising both British and foreign experts in fire matters, and if the conditions were somewhat more stringent than usual, it is certain that the manufacturers who secured gold and silver medals fully merit the public confidence.

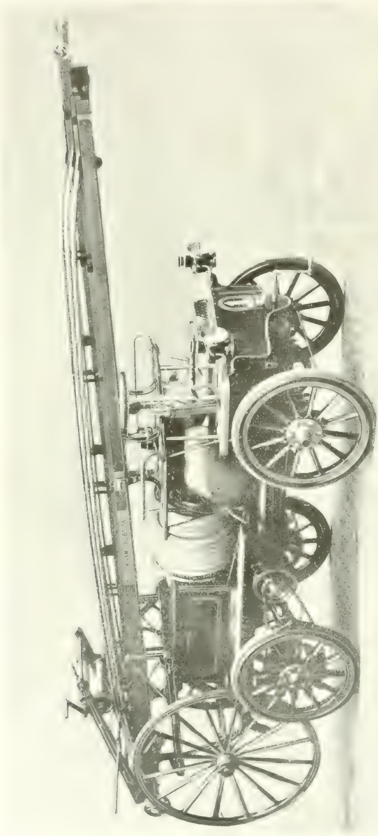
British firms, on the whole, held their own, especially in steam fire engines, but the gold and bronze medals offered by the Society of Arts for the best long ladders were both secured by German firms. Although of a more serious and instructive character than its forerunners at Earl's Court, this Exhibition proved a complete success, and the interest excited among the general public can hardly fail to stimulate both the aims of the British Fire Prevention Committee and the efficiency of all branches of the British Fire Service.

NOTABLE EXHIBITS.

It is impossible, within the limits at our disposal to give more than a brief account of a few selected exhibits, and we have made our selection from the various appliances shown by exhibitors who were awarded gold medals.

MESSRS. MERRYWEATHER & SONS' "FIRE KING."

The oil fuel motor steam fire engine, shown in the accompanying illustration is one of the "Fire King" pattern, built by Messrs. Merryweather and Sons for Liverpool. It is fired by means of vaporised oil, and is capable of pumping three hundred and twenty gallons of water per minute. Standing in the fire station the engine will be kept, by means of a gas jet, with about five pounds of steam always in the boiler, and on a call being received, the vaporised oil can be at once ignited, and in less than a minute and a half it can leave the station to respond to the call. It is fitted with very powerful brakes and excellent steering gear, and is at all times under the most complete control of the driver. Any speed up to thirty miles an hour can be obtained. On arrival at a fire, the driving machinery can be easily thrown out of gear, and the pumps put in, so that by the time the hose has been run out and the branchman is ready the engine can immediately commence pumping. The fire can be regulated at will by the engineer, who has it under complete control. The engine carries two cylinders containing thirty-six gallons of oil, or sufficient to last at an ordinary fire for several hours. Two tanks are fitted, one on each side of the boiler, for the storage of water, and a main feed pump works all the time the engine is travelling. There is also an injector placed in a convenient position in case the main feed should at any time fail.



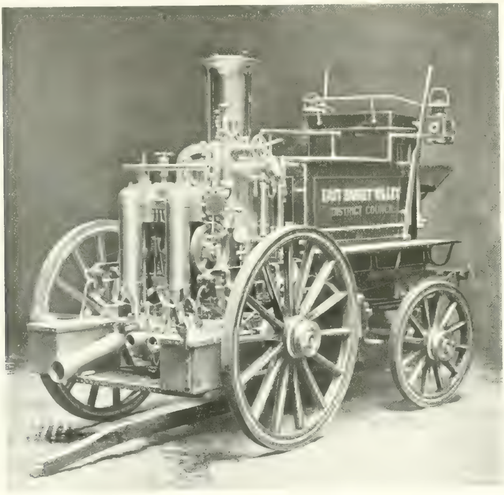
COMBINED MOTOR CHEMICAL FIRE ENGINE, HOSE TENDER AND FIRE ESCAPE, BY MESSRS. MERRYWEATHER AND SONS.

A COMBINED MOTOR CHEMICAL FIRE ENGINE, HOSE TENDER AND FIRE ESCAPE.

The combined motor chemical fire engine, hose tender and fire escape shown on this page, has been built by Messrs. Merryweather and Sons, of Greenwich, to the requirements of Superintendent Eddington, of Tottenham.

It has been designed for the special purpose of combining all the very latest and most scientific improvements intended to save life or extinguish fire. The motor is 20 b.h.p., and is capable of propelling the machine at three speeds, viz., fifteen, ten, and six miles per hour, or of reversing at the latter speed. It is entirely automatic in its action, and is fitted with electric ignition. The 50-ft. sliding carriage telescopic escape has specially designed fittings for shipping and unshipping the escape in a few seconds. The ladders are trussed with steel tubes up each side, thus ensuring a maximum amount of strength with a minimum of weight. In case of any one or more tubes being broken, they are capable of being replaced without in any way weakening the sides of the ladder. By an ingenious device, the same hoisting gear and winch which wind up the sliding carriage are used to extend the ladders.

The chemical cylinder is of polished copper with gun-metal fittings. It holds sixty gallons, and is fitted with acid bottle and patent apparatus for mixing the liquids. It is so designed as to be capable of using compressed carbonic acid gas if required after the original charge is exhausted. A brass reel carries one hundred and eighty feet of solid rubber hose for the discharge of the chemical fluid. The hose tender carries three hundred feet of 2¾-in. "double substance" hose. The couplings of this hose, as well as the heads of the standpipes, and all branches, are made of aluminium to reduce weight. The machine is designed to carry six men besides the driver. The Petrol Motor and Tender, as an accessory to a motor steam fire engine, constitute a valuable first aid. The hand chemical engines in the rear may be instantly brought into use, and the tender provides accommodation for long lines of hose.



MESSRS. SHAND, MASON AND CO.'S LIGHT "DOUBLE VERTICAL" EXPANSION STEAMER, FOR QUICK TURN-OUTS—CAPACITY 200-300 GALLONS PER MINUTE.

"DOUBLE VERTICAL" ENGINES BY MESSRS. SHAND, MASON AND CO.

The new patent "Double Vertical" variable expansion steam fire-engine for which a special gold medal was awarded Messrs. Shand, Mason and Co. by the Exhibition authorities is a double-cylinder engine, in which the steam cylinders and pumps are placed vertically at the rear of the quick-steaming boiler furnishing the motive power. The boiler is of the well-known inclined water-tube type introduced by the firm, in which, under ordinary working conditions, steam of 100 lb. pressure can be raised from cold water in from 5½ to 7 minutes. Amongst other interesting points of construction in the engines shown are (1) the application of variable steam expansion gear to regulate the power of the engine to the work to be done, thus effecting an economy in the use of steam with a concomitant saving in fuel, at the same time lessening the work of the engineer and enabling a considerable reduction to be made in the weight of the machine; and (2) the ingenious and effective arrangement for the utilisation of oil-fuel in place of coal. By the use of oil-fuel the time occupied in raising steam is appreciably shortened—in fact, where 20 lb. to 30 lb. of steam is maintained, as at the Metropolitan fire stations, it almost becomes a negligible quantity, 1 to 1½ minutes sufficing to bring the pressure to 100 lb. after the fire has been started. Steam pressure is maintained with far greater ease and steadiness than with coal fuel; there is also an entire absence of smoke, sparks, and flying cinders when the engine is working; no stoking is required, and no preparation necessary when the steamer returns to the station.

In the Shand-Mason patent oil-fuel burner a striking advance has been made in the direction of simplifying and perfecting the apparatus. The oil is stored in an oblong tank holding from 2½ to 3 hours' supply, placed in the fore part of the hose-box under the coachman's seat whence it is fed by gravity to the burner. In working, the oil is sprayed through three or more outlets on to a jet of highly super-heated steam, which disperses it into fine molecules and forces it against a baffle-plate in the furnace, ensuring thorough combustion. When starting with the furnace cold, air forced into the boiler takes the place of the steam-jet temporarily for spraying the oil. The supply of fuel to the furnace can be regulated as desired, each of the jets in which the feed pipe terminates having a separate stop-cock. Thus, when the engine is standing for any length of time the supply can be limited to a single small jet, or turned off completely, the relighting occasioning no loss of time.

DEMONSTRATING AT EARL'S COURT.

At present, however, the majority of engines are using coal and in the efficient working of such engines the stoking arrangements play an important part, In the Shand-Mason "Double Vertical," the fire door is placed at the side in preference to the rear, the side position affording greater freedom to both engineer and firemen while working. A further claim on behalf of this arrangement is that it permits of the centre of gravity being kept low, giving greater safety in travelling; the design of the engine is not cramped or limited, and a lower position of the suction inlet is permitted. Special means are provided for lighting the furnace without stopping, when *en route* to a fire.

The engine is strongly mounted on steel side-frames, springs, and axles with high wood-spoke wheels. The "Double Vertical" steam fire-engine is constructed in seven standard sizes, ranging from 200 gallons to 1,000 gallons per minute. Of these, two are here illustrated, the 200-300 gallon engine, one of the handiest and most convenient for general [illegible] and the very powerful 1,[illegible] gallon [illegible] the engravings showing approximately the relative sizes of the machines. It was a 450-500 gallon engine of this pattern which took part in the competitive trials before the jury of the International Fire Exhibition, giving better results than any other type. An engine of the 1,000-gallon size also furnished a remarkable demonstration of its powers at Earl's Court shortly before the close of the Fire Exhibition, when, in the course of the tests, a huge volume of water from a 2½-in. nozzle was hurled across the lake, a distance of some 300 ft., to the great admiration of the expert onlookers.

PORTABLE ENGINES.

In addition to "Double Vertical" Engines of various sizes, Messrs. Shand, Mason and Co. also exhibited an engine of their "Light Portable" type, a single-cylinder steam fire and pumping engine with patent quick-steaming boiler carried upon a two-wheel frame, and having a capacity of 100 to 150 gallons per minute. The steady working of this small engine and the remarkable distance attained by its jet created much interest. The engine has been found a useful machine for small estates, institutions, etc., for general pumping and fire-protective purposes where a larger engine is not required. It is a favourite fire-engine in the East, its portability and the small space in which it turns making it specially suitable for use in narrow streets. The firm's patent type of "London Brigade" Manual Engine, with new accessible valve arrangement and having hose and suction-pipe connections all at the rear, was also exhibited.

COMBINED HORSE FIRE ESCAPE AND HOSE CARRIAGE.

The Shand-Mason Patent Combined Horse Fire Escape and Hose Carriage, which gained for the makers a special award at the Earl's Court Exhibition, is their latest addition to life saving *matériel* for fire brigades. It combines (1) a telescopic fire escape of the Shand-Mason improved "Lattice Girder" type; and (2) a full-size pair-horse hose carriage or combined hose carriage and chemical engine. The object of the invention is, of course, to provide the speediest possible arrival at a fire of the life-saving apparatus accompanied by the firemen and appliances for dealing with the outbreak. The escape is carried horizontally upon the carriage, and the arrangements for disconnecting it from the carriage are practically instantaneous in action. Though forming one machine for travelling purposes, the two parts can be used independently, the carriage forming a complete and useful "first alarm" machine.

For cases where a horsed machine is not practicable, Messrs. Shand, Mason and Co. provide their "Curricle" Fire Escape. This has a similar ladder, and is rapidly and easily propelled by one or more men according to the size of the machine, which is mounted upon springs and steel axle between a pair of high wood-spoke wheels. Important points are the fine balancing of the machine and the automatic and other arrangements for quick-raising and extension.

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A MODERN DRAWING OFFICE.

BY

JOSEPH HORNER.

The author details the various requirements which have to be considered in laying out an engineer's offices. Attention is chiefly directed to the Drawing Office, some useful hints being offered on the subject of filing drawings and plans. The author also discusses the equipment of the pattern shop, with the allied questions of timber storage and pattern storage.—ED.

THE offices employed in an engineers' works comprise the commercial and the technical side; and excepting that they are housed in the same building, they have little connection with each other, being under different management. Their dimensions and relative importance vary; in fact, it is rather remarkable how widely opinions appear to differ as to the relative value the of office departments, the drawing department, or the clerical work being amply provided for in some, and starved in others.

THE COMMERCIAL DEPARTMENT.

The commercial side of the offices includes rooms for the principals, for the chief clerk, or secretary, for the various confidential and the correspondence clerks, and the typists. They must be fitted up with suitable office furniture. No modern office can be considered completely equipped unless fitted with a bureau for card filing. Though opinions differ respecting the value of card systems in workshops, there can be no question with regard to their value in filing orders and correspondence. The offices must be in telephonic communication with each other, and with the several departments of the works, in order to avoid incessant sending of messengers with its attendant waste of time, and the opening and closing of doors.

Brightness and restfulness should be studied in the decorations, and white or light neutral tints chosen for papers, paint, and ceilings, the latter being of importance in giving a diffused light by day, especially in offices where all the light available must usually be obtained from side windows. Incandescent lamps at the ends of flexible suspended cords, and provided with shades, are better than table lamps, or arc lamps, in the general offices.

THE DRAWING DEPARTMENT.

On the drawing office side the principal fittings are the tables, or desks, the boards, the drawers for the storage of drawings, tracings, and prints, and the printing department. The lighting and ventilating arrangements discussed in the last article include those for offices.

With regard, however, to artificial light, since drawing offices usually have a flat ceiling, this lends itself admirably to reflected light. Arc lamps with inverted shades throwing the light up to the ceiling painted white, or with a greenish or greyish tint, cast a diffused soft illumination over the room. The choice lies between these and suspended incandescent lamps. If the arc lamps are fitted in sufficient numbers they are preferable to incandescent lamps fixed over the drawing boards.

With regard to the boards used by the draughtsmen, I think that the old style of flat, or slightly sloping tables or desks is preferable to, and better to work on, than the upright boards with balanced tee-squares that are used in some offices, which for a great deal of work have to be brought into a horizontal, or slightly sloping position.

Each draughtsman requires a nest of three or four drawers underneath, or adjacent to, his table. In working out designs a large number of drawings is often required, both old ones, used for reference, and those which are in course of preparation, and for these the drawers are essential. A drawer for instruments, for note books, and reference books is also wanted.

DRAWING STORAGE.

One of the principal portions of the equipment of the drawing office is the drawers for storage. Drawings accumulate, and run into tens of thousands of separate sheets in the course of a few years, and it is necessary to have them so stored that any one can be turned up in a minute or two. This, too, notwithstanding that a single set of drawings will often be used for many separate orders, extending over several years, and also that single drawings will be selected for use on several different orders. This apparent difficulty is surmounted by having register numbers on every drawing, and recording these in a book or books thus.

DRAWING OFFICE OF MESSRS. ISAAC STOREY AND SONS, MANCHESTER.

Every drawing has a record of some kind written and stencilled on it, generally at the right hand bottom corner, but some records include more minute information than others. In a very complete system it comprises the name of the firm, the symbols used as order numbers, the consecutive number of the drawing, and its subject. To this many firms add the name, or initials, or number of the draughtsman who made it, those of the tracer, the name of the chief who passed it, the drawer in which it is stored, and the date.

A drawing in this system has two numbers, one being its own drawing number, the other the order number or symbol of the job to which it belongs. The first-named number is stencilled on it in the order of its completion, and is therefore different for every drawing, and opposite that number in the drawing record book is a description of the piece of work which it represents. It is not at all necessary that the whole set of drawings for one job should run in consecutive order in the record book. The numbers may run up to 1,000 or to 10,000, but at a certain stage, to avoid unwieldy figures, the numbers are separated by a letter of the alphabet, as A1,000 or A10,000, when B begins another thousand, and so on. By means of these rotational numbers recorded consecutively in the reference book, any drawings can be fixed at any future time.

The order numbers, or numbers for the job, are also stencilled or written on the drawings, and are recorded in the reference book. These have rotational numbers similar to the drawing numbers, but they constitute a distinct set. They are recorded in the book just noted, but also in another distinct book, which contains cross references to the drawing number book. It is better to use both books, but even then a sufficient space is left in the first-named drawing record book to enter up the successive order numbers for which drawings have been and will be used.

The drawers for the storage of drawings are usually lettered for the class of work done, and an entry is made opposite the drawings in the job order book, of the drawer in which they are stored. If lathes are the firm's speciality, the lathes are classified first according to type, and then by centres, in separate drawers. If cranes are made, types are separated, and these sub-divided in separate drawers, according to powers, as 1 ton, 2 tons, etc.

The job order book has recorded in it the successive order numbers of jobs, and under each is a complete list of all the drawings, prints, sketches used on each job, each one with its reference or drawing numbers. From this book the location of any drawing can be turned up opposite the drawing number in the rotational list in the drawing book.

The difference between this method and the card system is, that the latter is more elastic, the cards being filed in drawers which admit of extension as storage increases.

The general drawings should be put in the same drawers as the details, but a few drawers are often retained for general drawings only. Another distinction is that between office copies of drawings and shop drawings. The latter may be returned to the office on the completion of an order, in which case it is better to have a separate set of drawers for them. But in standard and stock work, always going on, the drawings remain in the shops until worn out and illegible. The latter are either mounted on boards or on rolls. In the storage of office drawings rolling is not to be commended. It is much preferable to lay out all drawings and tracings flatwise in their drawers. For isolated or occasional orders a single general drawing or set of drawings may suffice for all the shops, each department picking out its own particular section of work. Hand sketches alone may be sent out. Or sketches may supplement drawings, giving details that are either not quite clear or not fully shown. Or the sketches may be made for those departments that have little use for the drawings, as when a small portion of smithing or of plating only is wanted.

For standard work made in large quantities the general drawings are only sent out for the use of the assemblers, and of the foremen and managers who require them. The men all have drawings fully detailed of the work which they have to do, and nothing is left for them to scale or guess at, not even an unimportant radius, or length, or class of metal to be used. These perfect drawings are in strong contrast with some of the wretched general drawings from which men often have to work.

A NOVEL DRAUGHTSMAN'S EASEL.

In the drawing office of the James Keith and Blackman Company, Ltd., of Farringdon Avenue, E.C., a type of draughtsman's easel is used which is at once simple and convenient. The illustration on page 499 shows the general construction and arrangement clearly. On the two uprights of a standard, a light wooden frame is pivoted, carrying the drawing board; the frame can thus be placed at any angle from horizontal to nearly vertical and secured by brass quadrants and pinching screws as shown. The drawing board is balanced by two weights connected to it by screws and small pulleys; the T square being balanced and kept in position by another cord and pulley and similar weight, shown on the further side of the easel.

The draughtsman can thus work in either a standing or sitting position at pleasure, and not being bound by any rigid feature, he is free to consider his own health and convenience entirely and at the same time is much freer to push on with his work than if bending over the old-fashioned board. The Company have half-a-dozen of these easels in use, all of their own design and workmanship. This drawing office, as shown in the illustration on page 500, is a remarkably light one. There are plenty of windows, and after dusk the office is served mainly by the "Keith Light" (Intensified Incandescent Gas) which is a speciality of the Company. Three of these fittings, shown at the further end of the room, were lighted when our photograph was taken.

THE COPYING DEPARTMENT.

The printing department of the drawing office has acquired an importance equal to that of the drawing branch. I remember when there was no sun printing, and I saw the advent of the first set of blue prints in the shop, a set by the way that came with an order from France. Now sunlight is being rapidly ousted in favour of the electric light, either in the form of a reflector lamp projecting its rays to a flat printing frame, or in more recent forms the lamp is slowly lowered through a glass cylinder, round the outside of which is wrapped the tracing to be copied and the sensitised paper. Prints can be made thus in from two minutes upwards, according to the opacity of the copy and sensitiveness of paper. Daylight no longer controls the number of prints produced, and firms are able to meet a pressure of work that had to stand by when sunlight was depended on. This department does not require much room, and a lad can attend to it.

PHOTOGRAPHY.

A cognate department is the dark room. Many firms now make their own photographs, both of machinery, and also as a method of making reduced copies of drawings. It is then convenient to have a

MESSRS. [illegible] DRAWING OFFICE.

DRAFTING ROOM IN THE OFFICES OF THE BROWN AND SHARPE MANUFACTURING COMPANY, PROVIDENCE, R.I.

room for this in the office, with a copying camera, and screen suitably arranged for holding the drawings to be copied. Small machines or parts of mechanism may also be conveniently brought to this room for photographing; but when too heavy or unwieldy for this the photographer must go into the shops and take the machines where they stand. Even in this case, however, some firms have a special room or corner to which machines are run for photographing, and where the light can be arranged better than in the shop. The necessity for much blocking-out is avoided thus, as a suitable background can be permanently kept to stand the machines in front of.

ESTIMATING.

The estimating office is properly a sub-department of the drawing office. Frequently—generally perhaps—draughtsmen get out their own estimates of quantities and weights, but the estimating proper is done by a class of clerks who are familiar with all the costs involved in running a works, and of the materials [illegible] technical with commercial knowledge, and a long experience enables them to fix prices closely.

The fire arrangements need not be mentioned specially, but it is obvious that ample precautions must be taken in this department, where the drawings, papers, and accounts are of the utmost value to the firm. Portable fire extinguishers should be on every landing, and hand grenades distributed about in the other rooms.

PATTERN SHOPS.

The arrangements of pattern shops are not, as a rule, made a matter of so much thought and care as those of other departments. The reason is that the work done is mostly hand work, and that relatively to the foundry, machine, and some other shops, it engages but a small number of hands. A pattern shop with twenty men is a rather large one, as these shops go.

It matters little whether the pattern shop is on a ground floor or in an upper storey. In any case it is better to detach it entirely from the stores. If it is a two-storied building, one floor can be utilised for timber storage.

A Modern Drawing Office.

THE SHOP ARRANGEMENTS.

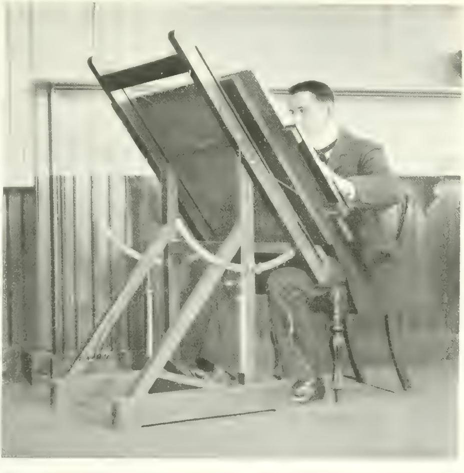
Most of the room in the shop is occupied with benches, then come lathes, saws, and planers. How these shall be disposed is a matter that depends chiefly on the relative length and breadth of the shop. In a square or nearly square shop a good plan is to have rows of benches down two sides, running crosswise, leaving a central space clear for machines, and for putting big patterns together on. Many of these, such as large engine beds, standards, girders and machine frames, cannot be put together on the benches; the bases and beds of heavy machinery, condensers, etc., are cases in point. Only in small work, as that of brass finishers, can this space be dispensed with. If a shop is narrow, one row of benches only can be laid down, leaving a side area for putting big work together. Then the machines had better go across the centre, leaving a break in the benches for this purpose. If they are put at one end, a good deal of walking is necessary from the benches at the farther end. A few double benches are necessary for work that is too large to go on a single bench, yet not large enough for the trestles in the floor area. The same benches, of course, serve for two men working singly on ordinary jobs.

The machines required in a pattern shop are lathes, small and large, selected to suit the general run of work done, ranging generally from 6-in. centres to 12-in. or even 18-in. centres, the latter with a specially long bed for pipe and column patterns. A large face lathe for wheels is one of the essentials in most shops. Its swing must be governed by the class of work done, and many range from 6 ft. to 8 ft. or 10 ft. A band saw, a circular saw, a planing machine, grindstone, and two or three trimmers or mitre cutters, are essential. These machines should be driven independently of other departments of the works, either by a gas engine, or a motor, driving a length of shaft whence all the machines will be belted. The circular saw, planing machine, and gas engine can, in a shop of fair size, be attended to by a handy man who is not a mechanic. Lathes are generally ranged down one side next the windows to secure all the light possible, and the shafting is arranged to suit.

Machines must be so arranged that there shall be room to handle the boards around them. The circular saw and planer must be unobstructed at the ends, by from 12 ft. to 16 ft., and the circular saw should have a good area clear in front to permit of cutting off ends of long boards. The band saw does not require so much clear room. A gangway of about 6 ft. wide in front of the lathes and between them and the ends of the benches suffices. The position of the foreman's office is not of much importance, as a pattern shop can be overlooked from any point.

The pattern shop can be sufficiently well lit with incandescent lamps suspended over the benches and machines, and perhaps two or three arc lamps to shed a general light. If the shop is a large one, the number of the latter must be increased. Many pattern shops have upper stories, so that daylight from side windows alone is available. This should be ample.

The pattern shop is specially liable to fire risks. It should, therefore, not be situated near the foundry cupolas, or close to a brass foundry, but be separated by a stretch of yard. It should, besides, be furnished with a liberal supply of hand grenades, and of portable fire extinguishers.



A SPECIAL PIECE OF DRAWING APPARATUS USED IN THE OFFICE OF THE JAMES KEITH AND BLACKMAN COMPANY, LTD., LONDON.

The draughtsman may work standing or sitting.

THE DRAWING OFFICE OF THE JAMES KEITH AND BLACKMAN COMPANY, LTD., LONDON.

PATTERN STORAGE.

Two adjuncts of the pattern shop have to be provided for—timber storage and pattern storage. The latter is of predominant importance.

When a firm can begin with a clean site unhampered by the accumulations of a generation or two, stores should be built in stories, to accommodate the heaviest patterns on the ground floor, those of medium size on a middle floor, and the smallest on an upper storey.

It [illegible] pattern [illegible] This is only practicable when patterns do not differ very greatly in dimensions, and also when they are kept strictly in standard sets; that is, when certain parts, as gear wheels, bearings, bushes, and so forth, are not taken and employed on a good many different jobs.

Speaking generally, three kinds of classification [illegible] according to standard sets of work, that according to mass or bulk of patterns, and that of standard parts selected from to be used indiscriminately in general orders. No confusion need arise in either case if a pattern register book is kept, in which all patterns made are entered, both by pattern numbers [illegible] the pattern [illegible] stamped to correspond with the first named, or with both of these, and an entry made of the shelf or shelves on which they are stored. This practice, variously modified, is adopted in all good firms.

Generally, in the basement the heavy patterns are laid directly on the floor, or preferably on strips of wood laid on the same. Some are suspended from the beams overhead by means of tar twine. Some are laid horizontally on iron rods standing out from wooden posts, each method being more suitable for some classes of patterns than others. On the middle and upper floors open shelving is arranged, and sometimes shelves formed as bins, besides which the board floors under the shelves are utilised. The shelves are arranged in parallel rows across the floor area, with gangways between, and from three to four tiers of shelves will occupy the height available to the ceiling. The shelves are numbered in rotation to correspond with numbers entered in the pattern book. Having, therefore, a number stamped on every pattern, core box, and loose piece, and entered up in the pattern register, with the number of the shelf on which it is stored, the [illegible] pattern [illegible] without [illegible]

The pattern [illegible] separate from [illegible] possible against [illegible]

NEW 25-TON HYDRAULIC COAL HOIST.

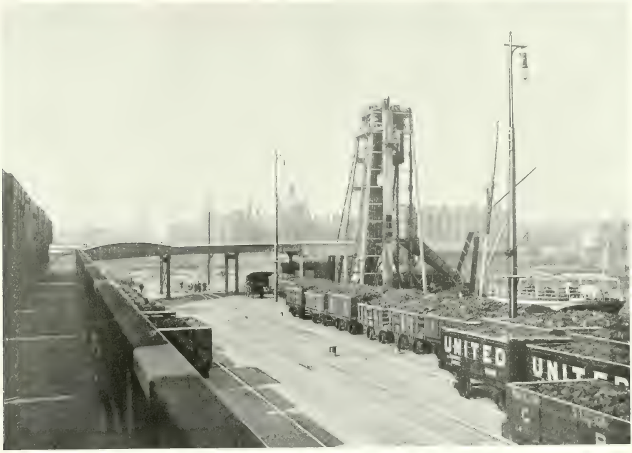
ONE of the largest hydraulic coal hoists yet constructed has been made by Sir W. G. Armstrong, Whitworth and Co., to the order of the Clyde Navigation Trust, for use at Prince's Dock, Glasgow.

The hoist is of the suspended pattern, in which everything except the holding down bolts is kept above the level of the quay, and which only requires as a foundation a solid block of concrete or masonry of sufficient size to take the base of the framing.

The hoist was originally arranged to lift wagons of a gross weight of 20 tons to a height of 50 ft. above the quay, but it was afterwards decided to increase the lifting power to 25 tons, which was effected by the addition of an assistant lifting cylinder attached to the framing. The loaded wagons reach the hoist at quay level, passing over a turntable and weighing machine, and after being lifted to the height required for discharging into the shoot, the empty wagons are lowered to the level of an elevated inclined gantry, by which they are run away to the empty sidings under the influence of gravity. A weighing machine is also provided on the high level adjoining the hoist for re-taring the empty wagons.

The hoist itself consists of a braced steel framing secured to the quay by holding down bolts. This framing forms the guides for the cradle on which the truck is lifted, which is fitted with a tipping frame by means of which the wagon can be tipped to an angle of 45° at any point in the lift of the hoist, the wagons to be dealt with being all fitted with end doors. The wagon, when tipped, discharges its contents into a shoot on the front of the framing, which is so arranged that it can be adjusted to suit the level of the ship being loaded. The heel end of the shoot is carried by brackets and pawls taking into racks on the front pillars of the framing, safety chains being also provided in case the pawls become disengaged. The point of the shoot is supported by chains leading over pulleys on the top of the hoist framing. When not in use the shoot point is topped up so as not to be in the way of vessels lying alongside. The point of the shoot is fitted with a pair of hinged doors for controlling the flow of the coal, and a removable lengthening piece for fitting on to the end of the shoot is provided. The adjustment of the shoot is effected by making a temporary attachment of either the heel or point or both to the lifting cradle. The lifting and tipping of the cradle is effected by hydraulic cylinders placed vertically on the side of the framing with the rams working downwards, one of the lifting cylinders being in constant communication with the pressure mains, so as to economise power when lowering the empty wagon.

The cradle and tipping frame are suspended by chains passing over pulleys on the top of the framing to the lifting cylinders already named. On one side of the framing is an auxiliary or anti-breakage crane having a lifting power of 4¼ tons, by means of which a box can be filled at the point of the shoot and lowered down into the bottom of the ship and there discharged. This operation being repeated until a cone of coal is formed in the hold of the vessel up to the level of the hatchway, to which the point of the shoot is also adjusted. This, in the case of tender coal, reduces the breakages in shipment, as after the cone is once formed coal can be tipped directly from the wagon without there being any fall from the shoot point. The crane is fitted with hydraulic lifting and turning machinery.



THE NEW HYDRAULIC COAL HOIST AT PRINCE'S DOCK, GLASGOW.

SHORTENING THE CROSS CHANNEL SERVICE.

Turbine Machinery and Electrical Cranes.

SOME time ago we were able to reproduce an illustration of the new turbine steamer "Queen," built for cross-channel service, at the instructions of the South-Eastern and Chatham Railway. The experiment appears to have been attended with results which have amply justified the high expectations formed at her trials. The introduction of turbine machinery in conjunction with the use of the new electrical cranes which have been erected for the Dover Harbour Board, has been instrumental in securing for the public greater comfort, and immunity from damage to luggage. The turbine steamer reduces the actual sea passage from pier-head to pier-head to about 50 to 60 minutes, as against 60 to 70 minutes by the paddle-vessels, besides giving much greater comfort and better accommodation on board. Moreover, the introduction of the electric cranes renders it possible to convey registered luggage between London and Paris in through boxes without the necessity of unloading at either port, in this way not only preventing wear and tear, but absolutely protecting it from the weather.

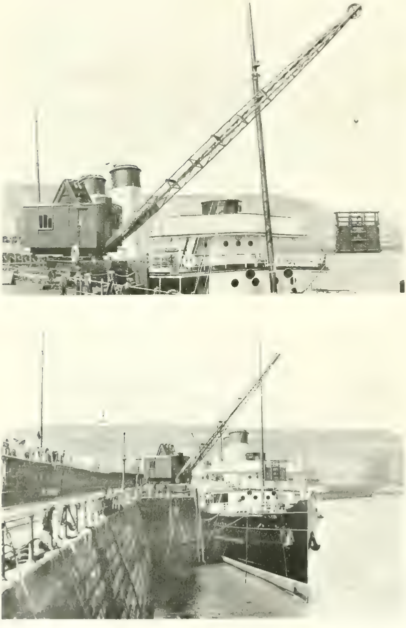
With regard to the actual time-saving, the Company has been able to accelerate the 11-35 a.m. express service from Paris to London by 15 minutes. Prior to the introduction of the turbine steamer, the increased traffic had outgrown the margin allowed for the transport in the ordinary way. This difficulty has now been met by the new arrangements.

Each crane is capable of dealing with loads not exceeding four tons at a maximum radius of 55 ft. and the jib is 60 ft. long. They have four motions, *i.e.*, hoisting, slewing, derricking, and travelling, and were constructed by Messrs. Grafton and Co., of Vulcan Works, Bedford the complete electrical equipment being designed by Messrs. Preece and Cardew, and supplied by Messrs. Siemens Bros. and Co., Ltd., to whom we are indebted for the photographs.

A 37-b.h.p. series motor, which runs at 420 revolutions per minute, drives the hoisting barrel through double reduction spur gear, and an 18-b.h.p. series motor, running at 310 revolutions per minute, operates the three motions of slewing, derricking, or travelling, by means of a series of clutches. Each crane house has its own switchboard.

Special cases have been designed to contain the baggage and mails to be used in connection with these cranes. The cases are carried three together upon one railway truck, but are lifted singly and transferred from the truck to the hold, or *vice versa*, as shown in the illustration.

The work of the staging, etc., was executed to the drawings of Mr. A. T. Walmisley, M.Inst.C.E., the engineer to the Dover Harbour Board, who superintended the erection of the cranes.



[illegible] and Co., Ltd.

THE NEW ELECTRIC CRANES AT DOVER.

THE new turbine passenger steamer *Brighton* is reported to have established a record. She succeeded in passing the pierhead at Dieppe two hours and 5[illegible] minutes after leaving Newhaven piers, a distance of 64 nautical miles, or 75 land miles. This represents an average speed of 21½ knots (25 miles) per hour

Official Tests at Watertown Arsenal.

STEEL SUSPENDER RODS FROM THE NEW YORK AND BROOKLYN BRIDGE.

THE annual report of the tests of metals and other materials for industrial purposes made with the United States Testing Machine at Watertown Arsenal, Mass., during the fiscal year ended June, 1902, shows that during the year some 3,650 specimens were tested. Among these were tests made on suspender rods from New York and Brooklyn Bridge, seven of which were [illegible] and [illegible] taken on July [illegible]th, [illegible].

Elongations and sets determined during the progress of the tests were by means of observations made upon the movable head of the testing machine.

The rods were pulled by attaching special fixtures to a pin passing through the eye at the head of the rod at one end and pulling against the nut on the opposite end, thus applying loads in the same manner direct tensile stresses would be received by the rods in place in the bridge.

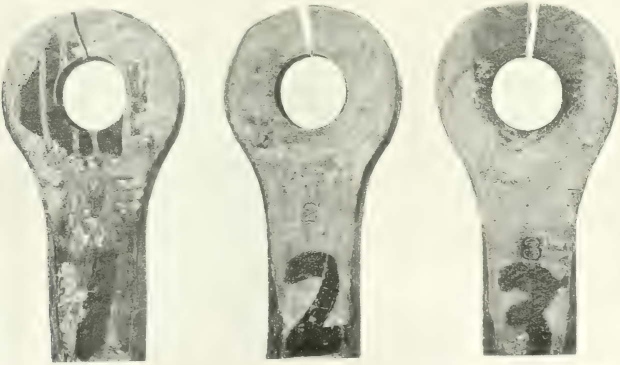
The attachment employed to secure the rods to the testing machine rendered the test pieces inaccessible at the time.

Incipient cracks at the roots of the threads in the old rods, Nos. 4, 5, 6 and 8, were developed by the tests. The cracks extended around part of the circumference of the rods, but were generally located at the extremities of the diameter which was parallel to the axis of the bridge. These cracks were seldom found on the sides of the rods taken crosswise the direction of the length of the bridge. Their disposition is regarded as significant with reference to explaining the causes which contributed to the failure in service of some of the rods by indicating the direction in which the overstraining forces acted.

The direct tensile stress on the suspender rods in service, under normal conditions of loading, is stated to be 11 tons.

ROD NO. [illegible], WITH NEW WELDED EYE.

Diameter of body, 2½ in.
Section area, 4·9 square in.
Gauged length over thread, 12 [illegible] in.
Gauged length over head, 5 in.


ROD 1. ROD 2. ROD 3.

TESTS OF STEEL SUSPENDER RODS FROM THE NEW YORK AND BROOKLYN BRIDGE.

Fractures in heads of welded rods made during testing.

The elongations tabulated below refer to measurements taken on the moving parts of the testing machine.

Applied loads.	In gauged length. Elongation.	In gauged length. Set.	Remarks.
Pounds.	*Inch.*	*Inch.*	
1,000	0	0	Initial load.
50,000	·08	·03	
75,000	·11	·04	
100,000	·14	·07	
123,000	·21 ·30	·13 ..	
125,000	·31	..	
145,000	..	..	Tensile strength = 29,600 pounds per square inch on body of rod.

Fractured through the head in front of the pin hole.

Appearance, granular, radiating from the seamy spot at outside of the head.

Elongation on gauged length over thread, ·17 in.

Elongation on gauged length over head, ·08 in.

Elongation of pin hole, ·09 in.

ROD NO. 2, WITH NEW WELDED END.

Diameter of body, 2½ in.

Sectional area, 4·9 square in.

Gauged length over thread, 12 in.

Gauged length over head, 5 in.

The elongations tabulated below refer to measurements taken on the moving parts of the testing machine.

Applied loads.	In gauged length. Elongation.	In gauged length. Set.	Remarks.
Pounds.	*Inch.*	*Inch.*	
1,000	0	0	Initial load.
50,000	·07	·01	
75,000	·10	·02	
100,000	·12	·04	
125,000	[illegible]	[illegible]	Set on gauged length over thread, ·03 in.
[illegible]	[illegible]	[illegible]	Set on gauged length over thread, ·08 in.
[illegible]	[illegible]	[illegible]	Set on gauged length over thread, ·19 in.
[illegible]	[illegible]	..	
[illegible]	..	..	Tensile strength = 40,000 pounds per square inch on body of rod.

Fractured through the weld in front of the pin hole.

Appearance, granular.

Elongation on gauged length over thread, [illegible] in.

Elongation on gauged length over head, [illegible] in.

Elongation of pin hole, [illegible] in.

ROD NO. 3, WITH NEW WELDED END.

Diameter of body, 2½ in.

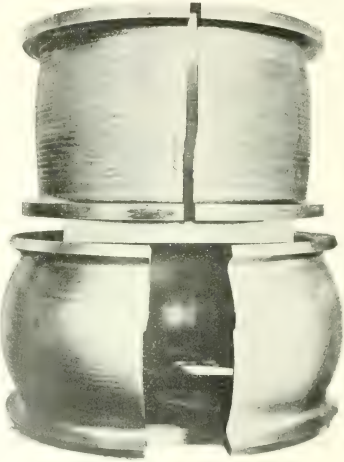
Sectional area, 4·9 square in.

Gauged length over thread, 12 in.

Gauged length over head, 5 in.

The elongations tabulated below refer to measurements taken on the moving parts of the testing machine.

Applied loads.	In gauged length. Elongation.	In gauged length. Set.	Remarks.
Pounds.	*Inch.*	*Inch.*	
1,000	0	0	Initial load.
25,000	·05	·03	
50,000	·08	·04	
75,000	·10	·04	
100,000	·12	·05	
125,000	·14	·06	Set on gauged length over thread, ·01 in.
128,700	·16	·09	Set on gauged length over thread, ·04 in.
140,000	·26	..	
150,000	·31	·22	Set on gauged length over thread, ·10 in.
160,000	·39	..	
164,300	..	..	Tensile strength = 33,500 pounds per square inch on body of rod.



TESTING GUN HOOPS.

Streaked and Unstreaked Hoops after fracture, showing the comparative ultimate distortion of the two. The upper Hoop, 17063 B3, Streaked. The lower Hoop, 17050 B4, Unstreaked.

Fractured through the head in front of the pin hole.

Appearance, granular, radiating from a seamy spot at the corner of the fractured surface, outside of head.

Elongation on gauged length over thread, ·24 in.

Elongation on gauged length over head, ·11 in.

Elongation of pin hole, ·13 in.

TESTING GUN HOOPS.

The other illustration shows the tests of two gun hoops: No. 17093 B3, a streaked hoop ; No. 17039 B4, an unstreaked hoop.

These hoops, one originally intended for a 10-in. A3 hoop, the other a 10-in. A2 hoop, of streaked and unstreaked metal, respectively, were tested to destruction by means of interior hydrostatic pressures.

The walls at the central part of each hoop, for a length of 15 in., were one half-inch thick. Flanges were left on the ends to reinforce the strength of the hoop over the hydraulic packings.

The testing was done with a fixture consisting of a body flanged at the lower end, over which the hoop was placed, and surmounted by a cap bolted to the body. An annular space, ·75 in. wide on a side, existed between the interior surface of the hoop and the exterior surface of the body, which space contained the hydraulic packings. The end thrust of the packings was resisted by the flange at the bottom of the body in one direction and by the cap in the other. Communication was established between the annular space and the testing machine through hydraulic piping, and the straining of the hoop was effected by admitting oil or water under gradually increasing pressures.

A caliper arm carrying micrometer points was mounted opposite the middle diameter of the hoop under test, and observations taken on the expansions and permanent sets acquired by the application of advancing pressures and their release. At pressures 2,000 lb. and 3,000 lb. per square inch below the elastic limits of the streaked and unstreaked hoops, respectively, the loads were applied and released 500 times with each hoop. Thereafter the pressures were gradually increased, passing the elastic limits of the material and approaching the limit of rupture.

The minimum values shown in the specimen tests of the physical qualities found in the specimens were as follows :—

	Elastic limit per square inch.	Tensile strength per square inch.	Elongation.	Contraction.
	lb.	lb.	per cent.	per cent.
Streaked hoop	54,000	102,400	15·0	38·3
Unstreaked hoop	56,000	110,000	12·0	35·2

CHEMICAL ANALYSIS OF STREAKED HOOP.

Carbon.	Manganese.	Silicon.	Sulphur.	Phosphorous.
per cent.	per cent.	per cent.	per cent.	per cent.
·040	·702	·277	·022	·022

Each hoop endured a stress 2,000 lb. and 3,000 lb. per square inch, respectively, below the elastic limit, repeated 500 times, without sensible permanent set in diameter. The elastic limit of each hoop under hydrostatic test coincided with the minimum value found in the specimen tests of the metal.

In ultimate bursting strength the streaked hoop showed a deficiency over the specimen tests ; the unstreaked hoop showed an excess in strength over the specimen tests. The numerical values obtained were as follow :—

HYDROSTATIC TESTS.

	Hoop.	
	Streaked per square inch	Unstreaked per square inch
	lb.	lb.
Elastic limit	54,000	56,000
Ultimate strength	91,051	125,889
Elongation (circumferential) per cent.	3·92	18·5

In circumferential elongation the relation of the hydrostatic to the specimen tests was similar to the results on ultimate strength. There was a deficiency of elongation displayed by the streaked hoop ; an excess of elongation displayed by the unstreaked hoop with reference to the specimen tests of the metal.

COMPARISONS OF THE RESULTS AND CONCLUSIONS REACHED.

1. The elastic limits of the hoops possessed the values indicated by the specimen tests.

2. Each hoop successfully endured 500 repetitions of a load closely approaching, but within the elastic limit of the metal.

3. The presence of streaks exerted a marked influence on the ultimate strength and elongation of the metal.

4. The actual bursting strength of the unstreaked hoop was 34,838 lb. per square inch above that of the streaked one, or corrected for the difference in the specimen tests of the metal the above became 27,238 lb. per square inch. Under the corrected figures the strength of the streaked hoop is 77 per cent. that of the unstreaked.

5. Compared with their respective tensile specimens, the following values appear : streaked hoop, deficiency in strength, 11,349 lb. per square inch ; unstreaked hoop excess in strength, 15,889 lb. per square inch ; the streaked hoop has 88·9 per cent. the strength of the specimen test ; the unstreaked hoop has 114·4 per cent. the strength of the specimen test.

6. The elongation of the streaked hoop was 26·1 per cent. that of the specimen test ; the elongation of the unstreaked hoop was 154·1 per cent. that of the specimen test.

7. The excess of strength and elongation of the unstreaked hoop over the specimen test is attributed to the reinforcing influence of the flanges of the hoop.

8. The deficiency in strength and elongation of the streaked hoop over the specimen test is attributed to the presence of streaks in the metal.

All of the streaks here referred to were of the type in which the continuity of the metal is wanting ; that is, they were seams existing in the steel. In addition to those measured, there were others of a less pronounced order which were not sensibly affected by stresses above the elastic limit of the steel. There were faint nebulous patches occasionally found ; clusters of minute irregular shaped cavities.

OUR MONTHLY BIOGRAPHIES.

MR. JAMES COPE CADMAN.

(President of the Institution of Mining Engineers.)

MR. JAMES COPE CADMAN, of Madeley, Newcastle-under-Lyme, is the descendant of an old engineering family, grandson of the late William Cope, of Milton, and son of the late John F. Cadman, mining engineer. Mr. Cadman was educated at one of the Woodward Schools, Sussex, and served his apprenticeship under his father and the late William Sherratt Cope, his uncle. After acting as surveyor to Messrs. Stanier and Co.'s extensive works at Apedale, Silverdale, Chesterton and Sneyd Green, he was promoted to assistant manager and finally acted as general manager to this firm until the retirement of Mr. Stanier. He was then offered and accepted a similar appointment with the Butterley Company at their Silverdale Collieries and Ironworks, which he held until the retirement of the Butterley Company some short time ago. At the present time Mr. Cadman practises as consulting engineer and valuer, and is agent for several collieries in the Midlands.

[illegible]

MR. JAMES COPE CADMAN.

Mr. Cadman's wide experience with the working of seams liable to spontaneous combustion, dealing with gob fires and the many difficulties pertaining to Staffordshire and neighbouring coalfields is well known. He has frequently been called upon to give assistance in connection with mining disasters in North Staffordshire as far back as the terrible disaster at the Fair Lady pit, Leycett, and his experience was in demand at the recent Talk o' the Hill explosion and Bunker's Hill inundation.

Mr. Cadman is one of the founders and an original member of the North Staffordshire Institute of Mining Engineers; he occupied the presidential chair during the years 1898-99.

Mr. Cadman's experience of iron manufacture was evident during his term of office as President of the Owners' Association when many difficult labour problems were settled.

He is a Past President of the North Staffordshire Coal Owners' Association, a member of the Staffordshire County Council, being an active member of the Technical Instruction Committee and in this capacity has done great service in respect to mining instruction for North Staffordshire. He is a member of the Iron and Steel Institute, Chairman of the Mine Owners' Association and acts as one of H.M. examiners for certificates of competency under the Coal Mines Regulations Act. Mr. Cadman was appointed President of the Institution of Mining Engineers in September last, in succession to Sir Lindsay Wood, Bart.

SIR CLEMENT LE NEVE FOSTER,

B.A., D.Sc., F.R.S., A.R.S.M., F.G.S.,

Whose Knighthood was announced in the recent List of Birthday Honours.

SIR C. LE NEVE FOSTER, whose knighthood can scarcely fail to cause the utmost satisfaction in mining circles has, within the crowded space of a few years, attained a unique position in the technical world. His training was well adapted for a strenuous career.

The second son of the late Mr. Peter Le Neve Foster, M.A., Barrister-at-law, his early education was obtained in France at the Collége Communal at Boulogne-sur-mer. Leaving the Royal School of Mines with a brilliant record, he proceeded to the celebrated mining college at Freiberg, in Saxony, in order to acquire the German language and study the methods in vogue at German mines and smelting works. In 1860 he was appointed by Sir Roderick Murchison, Assistant Geologist on the Geological Survey of Great Britain, being engaged in this work for nearly five years. During this period his evenings were spent in study and in making preparations for various examinations. In 1865 he duly qualified as Doctor of Science, and from this year until 1867 was lecturer on chemistry and mineralogy to the Miners' Association of Cornwall and Devon. The following year was occupied by explorations in Sinai and South America, while from 1869 to 1872 he was gaining valuable experience in the gold mines in Northern Italy. In 1873 came the appointment of Inspector of Mines. Other important points in the career of the new knight may be arranged chronologically as follows:—Assistant Juror for Mining at Paris Exhibitions (1867 and 1878); appointed member of the Treasury Committee on the Mining Record Office (1882); Juror for Mining at Paris Exhibition (1889); Knight of the Legion of Honour (1889); appointed Professor of Mining at the Royal College of Science, London (1890); Member of Royal Commission of Chicago Exhibition (1893); member of the Home Office Committee on Quarries (1893); Chairman of the Home Office Committee on the Slate Mines of Merionethshire (1893); Chairman of the Home Office Committee on Mining Statistics (1894); appointed Editor of the Annual Mineral Statistics, and of the Annual General Report upon the Mineral Industry of the United Kingdom (1894); Member of the Home Office Committee on Explosives in Coal Mines (1896); Member of the Home Office Committee on the Testing of Explosives (1898); Juror for Mining at the Paris Exhibition (1900); awarded "William Bolitho" Gold Medal by the Royal Geological Society of Cornwall (1900); Member of the Royal Commission upon Coal Supply (1901); Member of the Royal Commission St. Louis Exhibition (1903).

Photo by Elliott & Fry.

SIR C. LE NEVE FOSTER, B.A., D.Sc., F.R.S., A.R.S.M., F.G.S.

Sir C. Le Neve Foster has been consulted on various occasions by the Home Office with reference to amendments of the laws relating to Mines and Quarries for the carrying out of many reforms under the Coal Mines Regulation Act. He is an excellent linguist, and has been a frequent contributor to various scientific and technical societies, such as the Geological Society, the British Association, the Royal Geological Society of Cornwall, the Mining Institute of Cornwall, and the Mineralogical Society. In 1894 he published a work on Ore and Stone Mining, and his "Elementary Mining and Quarrying" is on the point of being issued.

It has been said of Sir C. Le Neve Foster that mines and mining would seem to be part and parcel of his existence. Not content with being amongst mines from day to day in the course of his ordinary official engagements, he has frequently spent his holidays in visiting mining centres abroad. His mineral collections have gained the medals of the International Exhibitions of Adelaide and Sydney.

DR. LEE DE FOREST,

Inventor of the de Forest System of "Wireless" Telegraphy.

BORN in 1873, at Council Bluffs, Iowa, U.S., Dr. Lee de Forest spent his boyhood in Alabama. He entered Yale University in 1896, graduating from the Sheffield Scientific School. Three years post-graduate work at Yale in the Sloane Physical Laboratory were largely devoted to the study of electricity and mathematics, and de Forest received the degree of Doctor of Philosophy in 1899 for research work in study of Hertzian waves, set forth in his thesis on "Reflection of Hertzian Oscillations at End of Parallel Wires." He was subsequently engaged in the Telephone Experimental Laboratory of Western Electric Company, Chicago, and, finding that opportunities were offered for original experiment, at night and after-hours, he promptly commenced searching for a new wireless telegraph receiver—one which should be entirely automatic in its action, simple and reliable, and distinct from the coherer.

DR. LEE DE FOREST.

Researches on a [illegible] principle of detector were continued for nearly two years before the "Responder" was considered a practical device. During this time he did night work at the Armour Institute of Technology, Chicago, acting as Assistant in Electrical Laboratory; and teaching mathematics in a night school, for his bare living expenses.

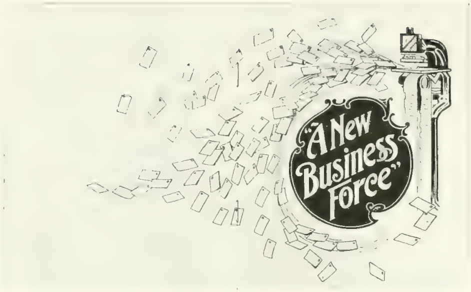
In the summer of 1901, de Forest came to New York where sufficient capital was interested to equip an outfit for reporting the International Yacht Races for the Publishers' Press Association of that city.

After many difficulties and discouraging delays, [illegible] and the "De Forest Wireless Telegraph Company" was incorporated, a laboratory and workshop being opened, and actual commercial stations constructed. The first work of importance was for the United States Army Signal Corps during the war manœuvres, 1902, where, in competition with the Marconi system, great satisfaction was given. Navy tests later in the year were also considered very satisfactory; in fact, from this time the system has steadily developed. Some fifteen stations have been erected on the Atlantic seacoast, five on the Great Lakes, and one in Porto Rico. Two are being constructed in Costa Rica, and another at Seattle, Wash.

Dr. de Forest was early to use alternating current machinery for transmitters, instead of induction coils, allowing high speed and regularity of operation. He has been allowed more than twelve U.S. patents, covering, among other things, a distinctive method of [illegible] by means of the parallel conductors sometimes known as the "[illegible]" wires, giving evenly distributive inductance and capacity and an accuracy of "tuning" not attained by the ordinary method of coils and condensers. He has pending patents for, and is working on, apparatus for duplexing the system, by which it will be possible to send and receive at same station simultaneously, a "syren" or automatic call for lighthouses, a "range-finder" for vessels, and the means for protecting the tuned receiver from the effect of an untuned wave [illegible] from the disturbance may [illegible]

CATALOGUE DESIGN.

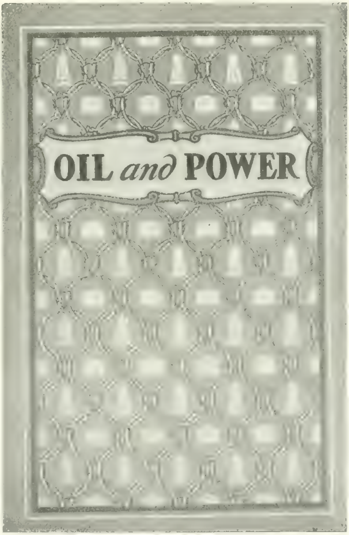
A Monthly Selection of
Notable Covers.



SHOWING FRONT AND BACK COVER

Oil and Power.

The cover illustration shows the outside cover of a highly artistic catalogue issued by the Vacuum Oil Company. The manufactures dealt with, are faintly yet impressively indicated in the design, by alternate series of tanks and derricks, which are shown in light grey on a darker ground of similar hue. The strands employed in the network are executed in gilt on black. The light grey colour is also used as a background to throw up the words "Oil and Power," which appear within the scroll. An excellent effect is obtained by the use of a thick black line in conjunction with a thin gilt border line. This is one of the most attractive catalogue covers we have seen for some time, and we need only add that the letterpress and engravings used in [illegible]



A New Business Force.

The Addressograph [illegible] our illustration, though it cannot give the colour effect, will serve to indicate the treatment employed. The artist has succeeded admirably in his representation of the idea conveyed in the title, "A New Business Force." The shower of envelopes not only covers the larger part of the front cover, but encroaches upon the back of the pamphlet, an excellent impression being thereby given of the speed of the machine. A bright red paper is used for the cover, which has a well-displayed text upon a black ground. Here we have a good idea, which has lost nothing in the execution.

A MODEL STEEL FOUNDRY.

Among the articles on Iron and Steel which have recently appeared in PAGE'S MAGAZINE may be mentioned the following: Iron and Steel Manufacture (series), by B. H. Thwaite, C.E.; A Modern Foundry Equipment, by J. H. Wicksteed; The Critical Position of Pig Iron; A Statistical Review of British Coal and Iron Production, by Benjamin Taylor; A Modern Continuous Rolling Mill, by Axel Sahlin; A Micrographic Study of Cast Iron, by Percy Longmuir; Some Foundry Practice at Sotteville Locomotive Works (series), by Charles R. King; The Teaching of Metallurgy: recommendations of the late Sir W. C. Roberts-Austen, K.C.B.—ED.

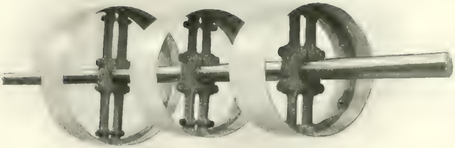
THE steel foundry at the new works of the British Westinghouse Electric and Manufacturing Company, at Trafford Park, is an excellent example of modern methods of steel making, practically the entire equipment having been laid down during the last twelve months. Electric power is used wherever possible. Two 50-ton electric cranes span the main aisle, while numerous smaller travellers and pneumatic jib cranes handle the lighter castings with economy and dispatch.

Among the most interesting apparatus are the Wellman-Seaver tilting furnaces charged in what is believed to be an entirely novel manner by electric power. The advantages of electric over-hand charging are well shown by the following table, from Mr. Williamson's paper on "Electricity in Workshops":—

	Hand charging.	*Electric charging.*
Capacity of furnace	40 tons	40 tons
Time taken	4 hours	½ hour
Men engaged per furnace	4 plus occasional help	2 plus $\frac{1}{6}$th of the operator's time
Wages per ton	2s. 8d.	1s. 3d.
Electric power	—	2¼d.
Charges per furnace per week	9	12

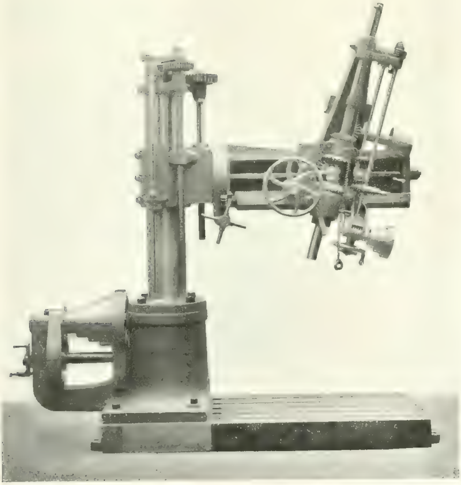
INTERIOR OF BRITISH WESTINGHOUSE STEEL FOUNDRY, TRAFFORD PARK, MANCHESTER.

WORKSHOP PRACTICE.



NEW PATENT "RING" PULLEY.

A RESUME OF MACHINE TOOLS, CRANES, AND FOUNDRY MATTERS FOR THE MONTH.

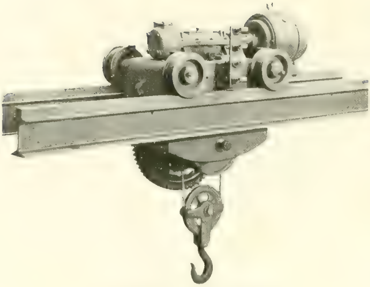


UNIVERSAL RADIAL DRILLING MACHINE, BY MESSRS. CUNLIFFE AND CROOM, LTD.

NEW PATENT "RING" PULLEY.

THE pulley illustrated has the boss, arms, and inner ring cast in one piece. It is then split in halves, the irregularity of the fracture making a close and inter-locking joint when the halves are bolted together. The boss is then bored and the ring turned on its face to afford a true surface on to which the wrought-iron rim is riveted. It is found that the combination of the ring with the two arms and the close joint gives great strength combined with lightness, while the turned ring secures a true-running pulley.

The makers—The "Unbreakable" Pulley and Millgearing Company, Ltd., West Gorton, Manchester—are building all their pulleys of 10 in., 12-in., 14 in., 15 in., 16-in., and 18-in. diameter on this "Ring" principle, using two rings for pulleys over 10 in. wide. They claim lightness, strength, convenience, true-running, and good appearance, as compared with either the cast-iron or wrought iron pulley of ordinary make, or wood pulleys. A great advantage in the "Ring" construction is the absence of the air fanning caused by the wide arms of the wood pulley.



UNIVERSAL ELECTRIC CRAB.

UNIVERSAL RADIAL DRILLING MACHINE, BY MESSRS CUNLIFFE AND CROOM, LTD.

The accompanying illustration shows a full universal radial drilling machine by Messrs. Cunliffe and Croom, Ltd., which is designed to drill the holes in different positions and at different angles on one objec without re-setting. The illustration shows a machine with a spindle 4-ft. radius, *i.e.*, drilling in the centre of an object 8-ft. diameter, the arm arranged to swing a complete circle. The arm is provided with power motion to raise and lower it 2 ft. on the circular pillar. The spindle is 2¼ in. diameter, provided with 12-in. self-acting and hand-down feed, quick release by counterbalance, and a motion is attached to the drill headstock for reversing the rotary movement of spindle when used for tapping. The arm is arranged to swivel on the face of sleeve carried by the pillar to an angle of 90 deg. in either direction. The drill headstock is also arranged to swivel on the arm to an angle of 90 deg. The maximum height admitted under the spindle is 4 ft.; the minimum height 2 ft. The foundation plate 5 ft. 6 in. long by 2 ft. 6 in. wide by 6 in. deep is planed on top and one side and is provided with bolt grooves for fixing work. The maximum ratio of gear power to spindle [illegible] to 1. The machine has a complete [illegible] [illegible].

NEW CAM MILLING MACHINE.

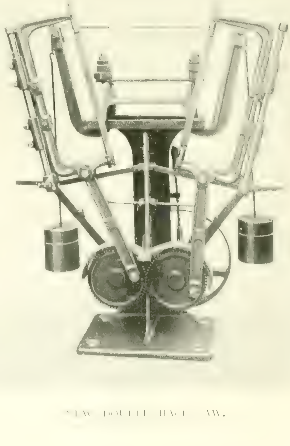
A new cam milling machine has been designed by the same firm for milling the face of grooved cams used in winding frames and similar purposes. The machine is made exceptionally rigid to overcome all vibration and so produce a perfect finish on the [illegible] and the bearings carrying the spindle are unusually large in diameter and of extra length.

The loose headstock has a sliding spindle of large diameter and is bored up taper and fitted with steel [illegible] carrying the cam to be milled. The cam is traversed in a rotary direction by means of a special carrier which grips the main spindle and drives the cam by the arms, avoiding all torsion to the mandrel carrying the cam. The throw of the cam is determined by the use of a suitable former, bolted to the faceplate, and a runner and weight placed inside the box body to give the necessary travel to the saddle carrying the milling head and cutter whilst the spindle carrying the former is making one revolution.

ELECTRIC CRAB FOR SMALL WORKS.

The universal electric crab, which is here illustrated, has been designed by the International Electrical Engineering Company for use in small works, where it can be adapted to existing hand cranes for any alterations necessary. The "universal" crab is constructed as far as possible on the same lines as the company's standard crabs for large travellers. The frame is cast in one piece, and is supported by four small wheels on which it travels. The motor, fitted with worm gearing for driving the drum carrying the lifting cable, is mounted on this frame.

The worm box is entirely enclosed and filled with oil. It is of a special type, and can be easily taken apart for examination of the various parts. The worm is of hardened steel, trued up on the grindstone, and runs in bearings fitted with ring lubrication. The worm wheel is of phosphor bronze.



NEW DOUBLE HACK SAW.

At the extremity of the worm shaft an automatic friction brake is fitted, combined with a ball bearing of the buffer type. This brake consists of two discs pressing one against the other. One of these discs is keyed to the shaft, and the other is fitted with a ratchet wheel and so arranged that it cannot turn in the direction corresponding to the lowering of the load. This brake is sufficiently powerful to hold the load suspended and, in order to lower, the motor must be used.

Two cords connected to the starting switch enable the motor to be run in either direction, and on their being released it stops automatically. For the longitudinal movement of the crab a chain and wheel are generally employed, but in some cases these are replaced by a cable attached to each extremity of the crab. When this is so the starting switch is not placed on the crab but is fixed at some convenient spot.

DOUBLE HACK SAW.

A novel type of power-driven hack saw is being made by Messrs. Beanland, Perkin and Co., of Leeds. This is provided with two saws working alternate strokes, and reducing the time taken in cutting by one-half. The machine is substantially built, and has a planed slotted table on which any section can be readily bolted. Particular attention has been given to secure stiffness of the arms or bows. There is an attachment for ensuring the blades being put in straight, and it is claimed that in cutting a 12-in. by 5-in. girder (taking less than twenty-five minutes) the blades will not deviate $\frac{1}{32}$ in. An arrangement is provided which ensures that when one of the bows has reached the centre of the cut it is pushed back sufficiently to allow the other bow to complete the cut. In feeding, each bow is drawn forward independently by a chain with adjustable weights. The feed can be suited to the keenness of the blade and the material being sawn. The gear wheels are machine-cut, and the slides or guides are adjustable.

HIGH-SPEED TOOL STEELS.

Since we last went to press Dr. J. T. Nicolson has placed before the Manchester Association of Engineers an important report, dealing with a series of experiments which were made to test the capabilities of high-speed tool steels. It was shown that speeds of from 110 ft. to 150 ft. per minute were possible for soft steel, 80 ft. to 110 ft. for steel of medium hardness, and 40 ft. to 50 ft. for hard steel. In the case of cast iron, speeds of 100 ft. to 110 ft. for soft, 50 ft. to 60 ft. for medium and 30 ft. to 40 ft. for hard were obtained—all these upon finishing cuts. It was also found that 45 square feet may be machined over in an hour by these rapid-cutting steels when operating upon soft steel with a cut $\frac{3}{16}$ in. deep, the figures for medium and hard steel being 30 and 18 respectively. With cast iron a surface of 42, 18 and 15 square feet may be turned off at the same cut in the case of the soft, medium and hard varieties respectively. Few specially heavy cuts were attempted, but it was found possible (when taking a cut $\frac{3}{8}$ in. deep by $\frac{1}{8}$ in. transverse) to remove 440 lb., 330 lb. and 180 lb. of cuttings per hour from the soft, medium and hard steel forgings respectively, and 450 lb., 200 lb. and 190 lb. from the soft, medium and hard cast-iron specimens. In one instance, with a $\frac{5}{8}$ in. by $\frac{3}{8}$ in. cut, cuttings were removed at the rate of 510 lb. per hour from soft-steel bar. The tests further showed that the forces acting upon the tool point, when cutting were over 100 tons per square inch of area of section of cut in steel, and from 50 to 80 tons per square inch for cast iron. One of the most noteworthy facts discovered was that the cutting force does not increase, but appears rather to diminish with increasing speed of cutting. An extraordinary feature about this is that it is contrary to the opinion generally held by turners and machine-tool experts, which is shown by the objections that are frequently raised by workmen to an increase of the cutting speed, on account of what they think would be the result, namely, a springing of the work. The tests have shown that this is an objection which can no longer be sustained. Although high speeds of taking a given cut will, of course, require a greater driving power almost in direct proportion to the increased speed, the force brought to bear upon the tool will be no greater, but rather smaller, and the loads acting on the belts and gearing, and the tendency of the lathe and work to spring, will be rather diminished than otherwise. A series of tests have, however, on the other hand, shown conclusively that heavy cuts at moderately high speeds are much more economical in power than light cuts at the highest possible speeds the tool can stand. The cutting speed, it has been demonstrated, does not increase as fast as the area of the cut diminishes, so that more material can be machined off in a given time with a heavy cut than with a light cut at its corresponding faster speed; whilst, further, the total horse-power required for cutting forms a much larger percentage of the whole at light cuts than heavy cuts.

SELECTING A PRESS.

Mr. R. B. Hodgson, A.M.I.Mech.E., has done a useful service by incorporating in a volume* his articles on machines and tools employed in the working of sheet metals. These originally appeared in the columns of the *Practical Engineer*.

Incidentally, Mr. Hodgson mentions the following points as of importance in selecting any screw or power press:—

1. Sufficient weight of metal used in construction of the frame casting to give strength and rigidity, and make it impossible to spring from its normal shape when dealing with the work for which it is intended, and ensure freedom from breakdowns.

2. The part of the press and its strips which guide the slide or ram in its motion should be carefully

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* "Machines and Tools Employed in the Working of Sheet Metals." By R. B. Hodgson, A.M.Inst.Mech.E. Published by the Technical Publishing Company, Ltd. Price 4s. 6d. net.

and accurately planed, being finished absolutely at right angles to the base, or table of the press, which receives the bolster or bottom die. This point is of particular importance in the case of a drawing or extending press of long stroke.

3. The slide or ram to be as long as possible, its bearing surface and those of its guide strips to be of sufficient area and of suitable shape to provide a steady motion to the tools, thereby preventing the cutting edges of cutting or forming tools being damaged after the slide or ram has once been properly adjusted.

4. The press bed, the ram, and the adjacent parts to be as heavy as possible consistent with the size of the press, to enable the principle of the anvil to be successfully carried out. Plenty of metal to resist the sudden blows to which the press may be subjected, and to reduce vibration to a low limit.

5. The details or smaller working parts, to be of sufficient proportions to give the necessary strength, and the wearing surfaces should have ample bearing surface, suitable metal being used for their construction, and hardened where necessary, durability of working parts receiving proper attention.

6. There should be ample room on the bed or table of the press to receive the various bolsters and dies, the ram, or any other working parts which have to take the variable positions to have sufficient length of adjustment. This point is of particular importance in the case of the ram, unless all bolsters, dies, and punches are designed to one standard length, which is not often the case.

7. The methods of manipulating the press, starting, and stopping the operating levers, and adjustments should be designed to give the greatest amount of ease and convenience in working.

In seeking out the foregoing points endeavour should be made to select the machine which, in its general design, is of shapely outline.

THE FUTURE OF THE CRANE INDUSTRY.

An "Elementary Treatise on Hoisting Machinery"* is the title of a useful work by Mr. Joseph Horner, dealing with the elements of crane construction. The author's long experience of crane matters fits him peculiarly to take a comprehensive view of the various types in use, and he has succeeded in compressing a great deal of valuable information in a short compass. Section I. is devoted to the elements of crane construction, formulæ have been avoided; Section II. is confined to the methods of operating cranes; Section III. to materials used for their manufacture; and Section IV. to the various types of cranes. "There are abundant indications," says Mr. Horner, "that the crane industry is passing through a period of transition which has had no parallel in any previous epoch of its history. The epochs of the introduction of water and steam had no promise of such far-reaching issues as those which are opened up by the introduction of electricity, and in a lesser degree of air, and by the increasing demands made by the manufacturers for better facilities for hoisting and haulage. Some of the old standard crane models are being quickly displaced by new types—the specialities of a few firms—and the time is fast approaching when most of the general crane makers will have to give place to the manufacturers of special types of hoisting machines, or else adopt their methods.

"This development is akin to that which is going on in other departments of engineering practice, notably in machine tools and high-speed engines. America and Germany have become very strong rivals to us in the crane building industry, especially in hoists and winches, overhead travellers, Goliath and gantry or portal cranes, high-speed electric lifts, and pneumatic cranes on overhead tracks.

"The principal developments have taken place in electricity and in air. With regard to the first-named, practice is still divided between single and multi-motor cranes, and between continuous and polyphase—usually three-phase currents. With single motor cranes a large starting torque is not required, and therefore shunt motors are preferable. Multi-motor cranes starting under full load must have a large starting torque, and they work intermittently. Either continuous or multiphase currents are suitable for single motor cranes. For multi-motor cranes the continuous current series wound motor runs fast with a light, and slowly with a heavy, load. But the motor will race if the load is suddenly thrown off, while the three-phase motor under these conditions will show little alteration in speed. It should, therefore, generally be adopted.

"An electric generating plant is now so indispensable in firms that the old objections to electric cranes no longer hold good; in addition to which, the areas of public supply companies cover the majority of instances, and are still increasing rapidly. Pneumatic cranes require an air-compressing plant, but this is not a large affair, and such a plant becomes almost indispensable in most works for other machines besides cranes, such as portable drills, chippers, caulkers, hose-pipes for foundry use, etc.

"The question of hoisting machinery is thus seen to be fast becoming a part of the broader question of the power equipment of works, and this has, and will continue to have, modifying influences in the working out of crane designs."

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* "An Elementary Treatise on Hoisting Machinery, Including the Elements of Crane Construction and Descriptions of the Various Types of Cranes in Use." By Joseph Horner, A.M.I.M.E. Illustrated with 215 engravings. Published by Messrs. Crosby, Lockwood, and Son. 7s. 6d. net.

THE NEW DOCKYARD AT GIBRALTAR.

BY

JOHN LEYLAND.

In this second article the object is to describe the Gibraltar Dockyard now approaching completion, in some detail, but the author has been careful to disclose nothing that might be thought confidential, it being the policy of the Admiralty to exercise a certain reserve in regard to particular details.—Ed.

II.

HAVING indicated the high strategic importance of Gibraltar, and the need that became apparent of providing it with a great harbour and dockyard, as well as the discussions that have arisen as to the policy adopted of placing the establishments on the western side of the Rock, I shall now proceed to describe their character, and the agencies and methods by which they are being advanced towards completion. It may be premised that the works, so far as they relate to the enclosure and defence of the harbour, are expected to be out of hand within the present financial year, while the adaptation of the port to the present needs of the fleet, being the dockyard extension, is not likely to be completed until the year 1905-6. The works were carried on for some time departmentally by the Admiralty itself, but eventually the construction was put out to contract to Messrs. Topham, Jones and Railton, of London. The Civil Engineer-in-Chief at the Admiralty, Sir H. Pilkington, K.C.B., is responsible for the general character and design of the work, but the actual duties are being carried on under the control of Mr. A. Scott, M.Inst.C.E., the Superintending Civil Engineer for the Admiralty. The chief agent for the contractors at Gibraltar is Mr. R. H. Taylor.

THE NEW HARBOUR.

The provision of a torpedo-safe anchorage made necessary the deepening and enclosure of a water-space of 440 acres by the extension of the Admiralty Mole on the south, the building of a Detached Mole, and the construction of a large Commercial Mole, the latter on the north side. This water space has been dredged to a minimum depth of 300 ft., and the dredging operations have extended over 215 acres. The Admiralty Mole, which ran out in a north-westerly direction from what is known as the New Mole Parade, has been lengthened by 2,700 ft., and a range of new coal sheds, 2,000 ft. long, has been built upon it. This mole is now completed, the finishing touches having been put to the roundhead that terminates it. An opening of about 600 ft. separates it from the Detached Mole, which has a slightly more northerly direction, and is 2,720 ft. long. It is already far advanced towards completion, and, when I saw it recently, the granite coping was being laid in many parts, and ships were lying alongside. The mole rests on a rubble base, and is formed of sloping blockwork—a system of construction which promises great durability, attention being paid to the necessity of keeping the surface of the rubble mound at such a depth that it will not injuriously affect the character of the waves assailing the work. It may be remarked incidentally, as a matter of interest, that a very strong tide sometimes runs round the end of the Detached Mole, and that already some change in the soundings just outside has been observed.

The enclosure of the harbour is completed by the Commercial Mole, of which the southern end is at a distance of about 600 ft. from the roundhead which terminates the Detached Mole. This Commercial Mole runs north for a distance of 550 yards, and then turns at right angles to the east, afterwards inclining a little south towards the Old Mole at the Water Port. The length of wharfage which will be available will be 9,348 ft., and coal sheds with a length of 3,175 ft., are to be erected. It is this northern work of the harbour that is the least advanced, but there has been no unnecessary delay, and rapid progress is being made. The advantage resulting from the construction will be very great, because not only will the Commercial Mole be available for the purposes for which it is intended, but it will afford facilities for coaling warships in case of need.

LABOUR AND MATERIALS.

The provision of labour for these great works has not been without its difficulties, but it has conferred benefits upon a large population of Spanish labourers and artisans, and the town of Linea, which is just to the north of the neutral ground, has prospered since the works began. At the present time about 4,700 men are employed, and it may be estimated that only one in ten is a British subject, in most cases an inhabitant of the Rock, or a man who has come from Malta. The Spanish workmen have rather a hard time, for they walk across the neutral ground daily—and the road, being in a no man's land, is peculiarly vile—starting very early in the morning, so that they may begin work at 6 a.m., and returning home after 5.30 p.m. They are rigorously searched by the Spanish Custom House authorities, and I was told that those who lived furthest away did not reach their homes until ten o'clock at night. They are hardy and frugal men, who mess together in the Dockyard, in parties of half a dozen or more. The labourers receive about 2¼ pesetas per day, and the masons from 3½ to 4 pesetas, according to their skill.

The supply of material was another matter for anxious consideration. A great deal of that required for the reclamation of land, to which I shall presently refer, has been obtained from the excavations for the docks, and by quarrying on the east side of the Rock, the stone, sand, and filling being brought by the railway through the tunnel. From the Rock itself already about four million tons of material have been quarried and used in the works. Between two and three million cubic feet of granite and limestone ashlar, the former from Aberdeen, Norway, and Italy, and the latter from Spain will be used. The Spanish quarries are at Peñarubia and elsewhere, and between 300 and 400 men are employed at them. An abundance of rubble stone is available on the eastern side of the Rock, and of sand suitable for making concrete and mortar there is an almost inexhaustible supply in the slopes between Catalan Bay and Monkey's Alameda. Blockmaking has been conducted on an enormous scale at an establishment on the North Front of the Rock, and the work is now mostly going forward for the completion of the Commercial Mole, the material being brought by railway from the Catalan Bay side. Blocks are made up to 40 tons, and there are three enormous goliath cranes, as well as a shipping jetty and a cantilever crane for the transferring of the blocks to the barges, which convey them to the places where they are to be laid. It may be interesting to say that 13,127 concrete blocks have been built into the extension of the Admiralty Mole, that 8,268 large blocks have been built into the Detached Mole, and that about 62,000 blocks have been set in the Commercial Mole. Concrete blocks are also used for the retaining walls of the New Mole Parade, which will be 1,858 ft. long, and the walls of the Dockyard extension, which have a length of 5,056 ft.

THE DOCKS AND RECLAIMED AREA.

The new docks are in the south-western angle of the harbour, where the old dockyard was, and the direction of their openings is to the north-west. They are being constructed where formerly was deep water, and the reclamation of land made necessary for their construction, and for the building of the dockyard offices, stores, and shops, which are on the west side of the harbour, under the North Jumper Bastion and the Alameda gardens, has been upon a large scale. The area recovered has been 47 acres. It may be here said that the dockyard proper extends from the Ragged Staff southward, and that the wharf edge is from 220 yards to 300 yards from the Bastion wall. The total length from the Ragged Staff south is about 800 yards, and then the frontage of the reclaimed space turns almost at right angles towards the Admiralty Mole, the new docks having their openings on this part of the frontage. A temporary dam was constructed by driving piles and puddling between outside the line of the docks, and the area having been pumped dry, the work of excavation and pumping went on rapidly. The ground was found to be hard and dry, and the contractors have had very little trouble, the only difficulty having occurred in the case of No. 3 Dock—that nearest the Admiralty Mole—of which the foundations had to be carried 12 ft. deeper than was expected.

Of the three docks, the smallest—that known as the King Edward VII. Dock, because His Majesty laid the coping stone—is furthest advanced. The steel caisson, which is to close it, was being placed in position recently, and the magnificent character of the masonry was most impressive. It may be said with confidence that no better dockwork exists in the world. The other docks are taking shape, and will be advanced with rapidity. The docks are respectively 450 ft., 550 ft., and 850 ft. in length, with a width at the entrance of 95 ft., and at the coping inside of 120 ft., while the depth at the sills will be 35½ ft. The largest dock will be capable of division into two portions by a sliding caisson, so that it will accommodate two vessels at the same time. The fine pumping engine house, in which are the main pumping engines, the drainage pumps, and the engines and accumulators for hydraulic pressure, is ready for its work. The pumping machinery will be capable of emptying the large dock in five hours, being equivalent to 105,000 tons of water in that period of time, or 4,700,000 gallons an hour. Before these docks could be put in hand, an enormous amount of excavation had to be undertaken, and, as I have mentioned, the vast weight of material taken out has been used in the work of reclamation.

THE DOCKYARD BUILDINGS.

The long ranges of buildings for the use of the Dockyard, which are now structurally complete and partly fitted with their machinery, are founded upon piles, and their masonry is of limestone. They comprise large workshops, stores, buildings, offices, and all the other requirements of a great dockyard. Altogether, they cover an area of eleven acres. A part of the constructors' building has already been taken over from the contractors. Many machine foundations have been put in, and machines fixed. The large stores are almost complete, as is the permanent hauling engine-house which has been used as a dockyard store. There is also a torpedo-store. The pumping engine house, as I have said, is ready, with its boiler room and coal store. Several great underground water tanks are being prepared, and two are already completed and in use. There are boathouses, new slipways, and a torpedo chamber, into which boats can be floated for repair.

The dockyard works, and those which are associated with them, include many other important features. A new magazine, for example, of great size, is being formed in the heart of the Rock, behind the Ragged Staff, and will be completed within about 2½ years. There is also a new cold meat store with refrigerating apparatus, to be used for the Navy and Army.

It will thus be seen that the Dockyard will be replete with everything necessary to fit it to serve as the base of a great fleet. Here ships can lie in any state of the tide alongside the Moles, where they can be coaled, and receive their stores and ammunition. Here also they can be docked for under-water repairs, even if they should be so damaged that they float deep in the water. The boiler shops and factories will undertake every class of machinery repair, and when the whole Dockyard is in working order it will be as efficient as any other British dockyard in the world, and will have the advantage of some of them in that its machinery and fittings will be of the latest pattern. It will possess everything that is necessary in steam, hydraulic, and electric power. The provision of skilled labour will, of course, be a matter of great consideration. Although Spaniards may continue to be employed, it will be mostly as labourers, and the skilled artisans must come from England. The dense population of Gibraltar already presents dangers, and it would appear that sooner or later something will have to be done to tempt some of the inhabitants to live else where if there is to be a large influx of British skilled workmen. The great dockyard is a magnificent work ; it has triumphed over many difficulties, and it will presently, with its splendid harbour, be one of the most valuable links in the chain of British Imperial defence.

THE DE FOREST SYSTEM OF "WIRELESS" TELEGRAPHY.

TRIALS BETWEEN HOLYHEAD AND DUBLIN.

DURING the month, Dr. Lee de Forest, with his chief assistant, took up their quarters in London in connection with a trial of the "de Forest" system of "wireless" telegraphy between Holyhead and Dublin, arranged for under the auspices of the Post Office. A brief sketch of Dr. de Forest's career will be found in another part of the MAGAZINE.

For the following description of the De Forest system, we are indebted to the *Electrical World and Engineer*. We are informed that a number of improvements have been since introduced, but, pending patents render it impossible to describe these at present. Dr. Lee de Forest's invention, which was developed by him in conjunction with Mr. E. H. Smythe, comprises a responding device for receiving, transmitting, and indicating electromagnetic waves, in which the electric oscillation builds up resistance in the responder, as the de Forest-Smythe wave detector is termed, instead of decreasing it as in the filings coherer, and yet the responder is not an anti-coherer, but is based fundamentally upon the laws governing electrolysis as produced by high-frequency currents. The resistance of the circuit, including the responder and the means of indication, is uniformly increased, and is proportionate to the energy of the received electric waves, the resistance being decreased again by the action of a local circuit. The action and reaction of the responder according to investigations of the inventors, is that the responsive device normally maintains a number of conducting paths, and these paths are interrupted by the oscillations set up by the received electric waves in the resonator system, which increases the resistance of the responder; but when the high-frequency currents cease, the local direct current reconnects the conducting paths instantaneously, and the normally low resistance is re-established.

By this method it is claimed that an instantaneous and automatic return is secured of the normal conditions of the detector after each series of oscillations are indicated and without any auxiliary apparatus for tapping back, thereby providing a detector of exceptional rapidity, certainty of action, and suitability for long-distance work—in short, fulfilling to a nicety the most rigid requirements imposed upon a detector in actual work.

The de Forest-Smythe responder is shown diagrammatically in fig. 1, and is connected with the resonator system and local circuit exactly as is a coherer or other wave-detecting device. *A* represents the aerial receiving conductor or antennæ, *G* the earthed terminal or grounded wire, and *E* the responder; the responder comprises electrodes or conductor plugs, e^1, e^2, forced in a glass or other insulating tube, *K*; the space or pocket, e^3, is filled with a special compound or medium which will be fully described below.

The local battery, *B*, provides current for actuating an indicator of any suitable type, but in actual practice takes the form of a telephone receiver; the local circuit includes the responder, a battery and choke coils, *C*, *C*¹, in oppositely disposed arms of the circuit as shown, and a resistance, *R*, usually made variable to provide a current suitable for the varying resistance of the responder.

The action of this responder is essentially of an electrolytic nature, for it was discovered by the inventors that when two metallic electrodes are slightly separated and included in series with a source of current, and a suitable medium is interposed between their opposed surfaces, minute metallic particles are detached from the anode and thence carried across the gap separating the electrodes to the cathode, where they build up bridges which extend toward and soon reach the anode, thus bridging the gap. In fig. 2 is shown schematically the metallic thread deposited by electrolysis of local current; and in fig. 3 the disruption of the thread on the passage of an oscillating current.

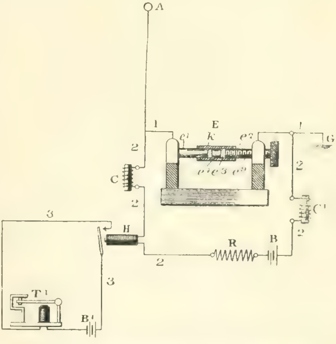
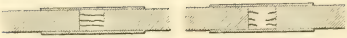


FIG. 1. THE DE FOREST-SMYTHE RESPONDER



FIGS. 2 AND 3 THE DE FOREST-SMYTHE RESPONDER BEFORE AND AFTER DISRUPTION.

It is evident that as long as electrolysis takes place the connecting metallic thread or bridge continues between the electrodes of the responder, which opens a practically free passage for the current derived from a cell; but the effect of high-frequency oscillations, such as are set up by impinging electric waves, is to instantly disrupt or break down the metallic threads formed by the local current when the resistance is increased by several thousand ohms.

The process involved in making and breaking these conducting threads is accomplished practically instantaneously, and if the responder is connected with a telephone receiver, the increasing and decreasing resistance of the circuit is manifested audibly.

Originally water was employed in the gap between the electrodes, which was sufficiently sensitive to indicate the electric oscillations, but it was neither accurate, nor permanent. By means of the microscope it was ascertained that when water was used between the electrodes of the detector a direct current from a battery deposits particles of metal from the anode, and deposits them on the cathode; and if the process is continued for some time, the particles continue to be deposited until a minute thread is formed connecting the electrodes, as shown schematically in fig. 2, and when this takes place feeble electric oscillations such as are produced by the received electric waves are unable to disrupt the metallic thread and the detector is said to be "clogged."

To eliminate this undesirable effect and to increase and maintain the sensitiveness of the detector, a great number of different substances were interposed between the electrodes and exhaustive tests conducted in order to ascertain a suitable medium. Viscous liquids, including glycerine and heavy oils, viscous semi-solids, such as vaseline powders, sulphur, oxides of lead and mixtures of PhO with glycerine and collodion and gelatine, were employed, as well as manganese dioxide and potassium chlorate. It was found that when these media were used they limited the number of threads or bridges built up by the local current and concentrated the action of the electric oscillations to and upon these threads. The effect of the oscillating current on the deposited metallic threads segregates and precipitates it quite gently instead of violently disrupting it, such an action being represented in fig. 3; when instantly this operation of the oscillations ceases the process of building up takes place.

The microscopical analysis made showed that when the oscillatory current is superimposed upon the local direct current, minute bubbles of gas are liberated at the cathode and along the deposited particles forming the deposited metallic thread; the investigations also showed that the segregation of the particles forming the thread is directly due to this sudden generation of gas, and that the action is "largely one of disruptive electrolysis in a film of electrolytic liquid interposed between each metallic particle and its neighbour."

To fulfil the theory thus evolved it is necessary to introduce some suitable electrically decomposable medium, such as water, with the supporting medium, in which the particles forming the thread are suspended. In practice commercial glycerine is used, and fulfils the above requirements nicely, since water exists in commercial glycerine as an impurity.

The investigation also indicates that the gas liberated is hydrogen, and the oxygen set free effects a combination with the metal of the anode, or in the case where glycerine is employed as the sustaining medium, "the chemical activity of the nascent oxygen may be sufficient to cause it to abstract hydrogen from the glycerine to form water."

The inventors, in their patent, state they have obtained the best results with the oxides of lead, and that these substances act as a depolariser as well as a sustaining medium. The gas arising from the electrolytic processes referred to above, may be absorbed by substances such as finely divided sulphur, which are interposed between the electrodes.

The terminal conductor plugs or electrodes employed in the responder are about an eighth of an inch in diameter, and separated one-sixteenth of an inch. The oppositely disposed surfaces may be either smooth or roughened. A screw adjustment is provided for determining accurately the sensibility of the responder.

A complete detector is shown in fig 1, and consists of an insulating tube, *K*, of glass or ebonite, an auxiliary electrode, e^4, being forced between the electrodes, e^1, e^2, proper. In the spaces or pockets is the sensitive

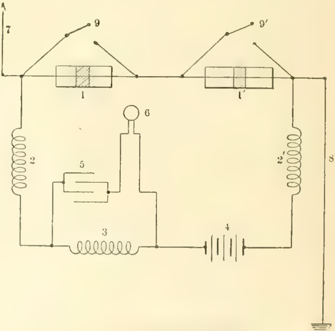


FIG. 4. DIAGRAM OF RECEIVER.

medium, composed of rather coarse filings and oxide of lead in equal proportions by bulk and made into a paste by the addition of glycerine or vaseline with a trace of water or alcohol. The local circuit should have a small value, preferably one-tenth to one milliampere, or when two cells are inserted in the circuit a resistance of 12,000 to 15,000 ohms is necessary to obtain the proper relative values.

It may be mentioned that the "de Forest" system was installed in Sir Thomas Lipton's yacht *Erin* last summer, when as many as ninety messages in a day were sent and received on the yacht. Sir Thomas Lipton reports that he has used the system very extensively, not only for inland messages, but also for the sending and receiving of many cables from all parts of the world. Many of these cables were in cipher code, but without exception all were sent and received correctly. He believes the day will come when every ship will have wireless apparatus on board.

The stations at Howth and Holyhead, which are just completed, include each a small Fairbank-Morse gasoline engine, belted to a 1-kilowatt 60-cycle 500-volt alternating current generator. The generator circuit includes a high-speed key, exactly similar to the Morse key, a reactance-regulator, and the primary of a 20,000-volt transformer, charging the condensers. Two of these are in series, and contain a special helix and spark gap in circuit. The size, clearness of the spark, being absolutely white and devoid of flame, and the ease with which it is manipulated, even at great speed by the key, are notable features of these de Forest transmitters. The antennæ are of peculiar construction, consisting of five small flexible cables, considerably longer than the mast is tall, branching out in a wide fan, and bowed out in the middle by small cord guys and "spreader." The whole fan presents an immense radiating and collecting area, and yet exerts the very minimum of wind resistance, and is almost invisible.

The Holyhead station stands on the crest of a precipice over 400 ft. above the sea. The ground connection is to a few small copper plates sunk edgewise in the shallow soil on the top of the rock, and to the station-house itself, which is sheathed with iron. On account of the height and inadequate quality of the "ground" possible at this station it is probable that the waves radiated therefrom are chiefly in the form of pure space radiations, and not the grounded, sliding waves such as emanate from a station at sea level, grounding in the water.

The electrolytic receiver which Dr. de Forest is using in these Post Office tests differs somewhat from that described above, inasmuch as the regulation of local current flowing therein depends on the property of the electrolytic cell to *rectify* the Hertzian oscillation, allowing only that half of the wave to pass which coincides in direction with that of the local battery. When the two e.m.fs. act in conjunction, the opposing e.m.f. of the electrolytic cell is overcome, and the flow of local current is momentarily increased. This is the type of electrolytic responder first tried by de Forest in 1900, and lately perfected. It has the advantage of requiring no adjustments, and is so reliable and indestructible that it is uninjured if absolutely unprotected from the heavy transmitter spark a few feet distant, but is always responsive in case the distant operator wishes to "break" the sender at the other end of the line.

The Junior Institution of Engineers.

THE annual general meeting of this institution was held at the Westminster Palace Hotel on October 24th, the principal business consisting of the Council's report and accounts, and the election of officers for the ensuing year. The report stated that the total membership was now 746. Ten meetings for the reading and discussion of papers had been held, the institution premium having been awarded to Mr. R. W. Newman, Assoc.M.Inst.C.E., for his paper on "The Effect of Design on Methods of Construction from a Contractor's Point of View." Twelve visits to engineering works, etc., had taken place, in addition to those of the summer meeting, occupying one week, Sheffield and the Peak district having been the *rendezvous*. The accounts showed that the sum of £300 had been invested, and that the income had been £156 more than the expenditure. The election of Mr. J. Fletcher Moulton as the new president, proposed lectures on the Theta-phi diagram, by Professor John Perry, library, certificate of membership, and Fire Prevention Congress were referred to in the report. The election resulted as follows: Chairman, Mr. S. Cutler, junr.; Vice-Chairman, Mr. Adam Hunter; Hon. Librarian, Mr. H. T. Gould; Hon. Auditors, Mr. H. N. Gray and Mr. H. B. Vorley; Members of Council, Messrs. J. N. Boot, W. H. de Ritter, A. H. Huddart, and J. H. Pearson; Provincial Members of Council, Messrs. V. H. Chabot, T. D. Evans, E. King, W. E. Lilly, F. S. Pilling, and E. W. Porter. The programme of papers for the new session was announced: November 20th, "Fires on Shipboard," by Mr. G. Canning. December 4th, "Gas Engines," by Professor D. S. Capper. January 22nd, Mr. Moulton's Presidential Address. February 5th, "Producer-Gas Power for Ice Factories," by Mr. Hal Williams. March 4th, "Electric Storage Batteries," by Mr. G. C. Allingham. April 8th, "Heating and Ventilation of Factories," by Mr. K. Gray. May 6th, "The Design of a Dry Dock," by Mr. A. W. Young. Those of our readers desiring particulars of membership of this useful society should communicate with the Secretary, Mr. W. T. Dunn, 39, Victoria Street, Westminster.

Machinery Wanted.

WE are asked by a well-known firm to supply the names of manufacturers willing to undertake machinery for the following purposes: (1) To efficiently clear soft mud and silt to about 4 or 5 feet in thickness from the bottom of large tidal tanks, and to convey and discharge same at various distances up to 300 or 400 feet away. (The machinery and fittings for the purpose must be portable and strong to move from place to place.) (2) A complete equipment of travelling bands and elevators or other suitable machinery for conveying grain, say, to the extent of about 3,000 tons in twenty-four hours, to and from grain warehouses, and feeding same to mill.

The Education and Training of Civil Engineers.

BY

J. GORDON HAYES, C.E.

Enforces the necessity of specialised school education for embryo civil engineers, and a good grounding in science. The author also gives his views on subsequent training, showing that the chief desiderata for the successful civil engineer are hard work and brains.—Ed.

DURING the last few months the readers of this magazine have been favoured with the opinions of some high authorities upon the training of engineers; attention has been chiefly given to the mechanical section, however, and what little has been said on the subject of the civil engineer concerned chiefly one particular class, and quite a minority of the members of the "civil" community. That this is so I shall hope to show as we proceed, but my object first is to issue a plea for more suitable guiding principles during what I will term the "primary" stage of education. The whole subject can for convenience be aribitrarily divided into the primary or "scholastic," and the secondary or "professional" periods.

The education proper of the engineer may be said to commence with his schooldays, not later; and if it be denied that this is so under our present system, the reply at once is, that the system is wrong. From time to time thinking men have pointed out the irrationalism of our public school and university courses for any but those destined for the Church. Sydney Smith, in his day, tried to raise a standard against these stupid customs, one of his remarks in the *Edinburgh Review* being: "The test established in the world is widely different from that established in a place which is presumed to be a preparation for the world." And is this not true? One of our greatest thinkers, Mr Herbert Spencer, has pressed the same thought upon us in his own unparalled manner, and it is my firm conviction that Britain cannot keep her place in the forefront of the nations unless the useful elements of education at least preponderate over the ornamental, and scholastic training be devoted almost exclusively to effective work. In some quarters this is slowly being realised, but it is still useless to deny that the greater part of our school curriculum is absolutely non-effective as far as the training of an engineer is concerned. Why, then, should we submit to an irrational system, at the close of which a lad sadly finds that his labour has largely been lost? Why has he to begin afresh on new lines of study at a time when the rudimentary parts of such studies should be his second nature? Why, I ask, should it be necessary to individual success that the youth surrenders all his leisure hours, and is forced to burn the midnight oil for years to make up his leeway?

THE SCHOLASTIC STAGE.

Let us consider briefly what subjects are necessary for an engineering career, and what may be omitted from the scholastic stage. But before we are in a position to choose or reject we must inquire how our selection is to be made; that is, upon what grounds we are to base our decision. Now in the first place, it seems very clear that children should be *taught to think*; brain building, therefore, is of the first importance, the development of the faculties the great desideratum. In the second place the mere accumulation of unrelated facts should be avoided. I might remark *en passant* that the reason why so few "clever" boys turn out successful men is to be found just here: that, as a rule, they merely have a capacity for "cramming" their heads with facts and formulas which enables them to pass examinations as they are at present constituted, but which faculty we might recollect (did it not seem cruel) is possessed in a remarkable degree by the anthropoid apes! Whereas the "dull" boys have not exactly a "receptacle" upon their shoulders, they possess creative minds which develop slowly, but which in conformity to biological law, when they are mature, are more powerful and capable of thought.

But to return. The best mental exercise known to man is scientific study and research. It promotes original thought, and is precisely the class of knowledge required in after life; that is to say, all the laws grasped by the student will be turned to good account in his profession; moreover, the sciences are no mere agglomeration of dead facts, especially if properly taught on synthetical principles. It will have been surmised already that what we mainly advocate for our schools is science, and such is, indeed, the case after attention has been given to the very necessary preliminaries of reading and writing, the English language, arithmetic and also drawing. Ornamental subjects, such as Latin, Greek, French, German, history (as usually taught), literature, and so forth, should be regarded in their true light of accomplishments, and as such some of them might be indulged by way of home work (if that be allowed), and in particular cases one language may even be a necessity. May I say in parenthesis that it is to be understood we are speaking somewhat generally; we are making, as it were, our preliminary survey, the exact line is not yet ascertained at every point, though the route may have been fixed. It will hardly be denied, I think, that a good grounding in science is the very best preparation for the life of an engineer, and I therefore submit the following schedule as embodying the essential features (together with the subjects already recommended) of a rational system: Geometry, plane and solid; pure mathematics, euclid, trigonometry and algebra; the physical sciences, mechanics (of solids and fluids), heat, light, electricity and magnetism, chemistry and physiology, and the concrete sciences geology, geography, meteorology and astronomy. Anything approaching an exhaustive knowledge of these is not, of course, possible even were it to be desired, and it would be superfluous; but I contend that equipped with a fundamental grasp of the first principles the youth who stands upon the threshold of the engineering world will find himself in possession of an armament that is to be seriously reckoned with, and is not easily to be overcome.

TRAINING OF THE CIVIL ENGINEER.

We now arrive at the secondary or professional stage, the training proper of the civil engineer, and it is here that the writer humbly dares to cross swords with the learned professors who assume that the only portal into the profession is through an engineering college. Not that he underrates the value of such a course of study, on the contrary, he regards it as an almost inestimable privilege to be able to pass through these institutions; but that it is the only "front door," or even in all cases the best, he emphatically denies. It is, to speak plainly, a "straight gate and a narrow way, and few there be that enter" the civil engineering profession thereby, for the tolls are heavy and altogether additional to the unavoidable premium which must follow in any case, as even college students are obliged to be articled. I aver that not 25 per cent. of our civil engineers take a college course, and that, in passing from quantity to quality we find our eminent men have usually achieved success without it. Indeed, on this point one need hardly assert that it is hard work and brains which make the engineer, and that nine individuals out of ten who enter our profession wealthy fail to rise by unaided individual effort and personal merit

Dealing, then, with the majority of embryo engineers (and also with college men at the completion of their course), these having very properly paid their premiums become articled pupils to some recognised civil engineer. Their studies should then include a continuation of the subjects prescribed for the scholastic period, some two or three of which should subsequently be pursued alone, those chosen being the sciences upon which the branch of engineering the pupil is to follow are based. Thus, to give but one example, is he destined for a water engineer he will devote himself particularly to hydrostatics, hydraulics and geology. Several technical subjects are now introduced, such as geodosy, building construction, sanitary engineering, machine construction, according to the special branch that is being followed, which, be it railway or harbour drainage or bridge work, the pupil will now have to study. In all these he will see the scientific principles he knows so well being worked out in a practical manner. He will begin to practise geodosy, and must aim at such proficiency in surveying and levelling that he may be competent to undertake any such work on his own account at the expiration of his articles. He has to learn accurately to plot his field work, and how to make finished drawings of plans, sections, details of structural, and it may be also of mechanical work. Draftsmanship, to those of an artistic temperament, or who are fond of drawing, will be a pleasant recreation, while those whose tastes are otherwise will do well to assiduously apply themselves to so necessary a department of their work. In either case the rudiments will have been passed at school, and the pupil will have a facility for handling his instruments.

In the manner indicated, unless the pupil be both gifted and persevering, two years will have been well spent. He should then be capable of taking out quantities, drafting specifications, and pricing out estimates, besides getting out original designs for small works or for portions of larger works. He should, moreover, be gaining experience on works under construction, and will doubtless assist the resident engineers a good deal during fine weather. He must get some practice in setting out work, as also in measuring up and keeping the account of work done. To ensure the best results two things are essential—a suitable course of instruction and a youth who will work. We have sketched out our notion of the former, and though conscious that it will be found wanting in many details, trust that the effort will at least call forth useful criticism from our successful civil engineering practitioners, who are the best qualified to judge.

PWLLHELI HARBOUR WORKS.

A brief account of the new works which have been undertaken to develop the Welsh fishing industries.—ED.

THE foundation stone of the new Harbour Works at Pwllheli was laid on October 27th by Mr. Ritchie, M.P., who was accompanied by Mr. Lloyd-George, M.P. Both gentlemen received the freedom of the borough. Mr. Ritchie, in the course of his speech acknowledging this honour, said he had pressed upon Sir Michael Hicks Beach, when Chancellor of the Exchequer, to allow a Bill to be brought in enabling the Government to assist local authorities with light railways, and the same principles had guided him with regard to voting money towards harbours of refuge. The success of the Light Railways Act had been very great, and when a case had been made similar assistance was promised for the formation of fishing harbours conditionally upon the locality finding a large proportion of the expenditure required, and undertaking the maintenance of the harbour. The first proposal of Pwllheli was unsatisfactory, but subsequently a proposal involving the expenditure of £60,000 was put forward and a grant was made. The new harbour would be of enormous service to that large stretch of coast, and he hoped it would contribute to the general prosperity of the town. A few remarks by Mr. Lloyd-George followed.

For the ceremony of laying the foundation stone Mr. Ritchie was presented with a silver trowel.

The scheme now undertaken has been under consideration for several years. The advice of Mr. W. T. Douglass, M.Inst.C.E., of Westminster, the Consulting Engineer to the Corporation, was sought by the borough as far back as January, 1896, when he prepared an outline scheme for the improvement of the harbour and its approaches.

The present complete and more detailed scheme is estimated to cost £57,500.

His Majesty's Treasury, on the recommendation of the joint Board of Trade and Treasury Committee on Harbour Grants have promised a free grant of £22,500 towards the cost of the work. The Cambrian Railways also make a contribution of £20,000 towards the cost of the scheme in return for facilities which will be afforded them for the construction of a new railway station and extension of their line into the centre of the town.

A contract has been entered into with Mr. E. R. Lester, of Plymouth, for the execution of the whole of the works, which may be briefly summarised as follows: On the north side of the existing harbour, which dries at about half tide level, leaving exposed a wide expanse of mud flat, will be constructed an embankment some 2,470 ft. long, extending from the existing railway station to the outfall gates of the Afon Rhyd Hir at a point known locally as Spion Kop. A considerable length of this embankment will be in the form of a vertical concrete wall, and the remainder will be faced with stone pitching in the form of a sloped bank.

The bed of the harbour on the north side of this wall to the extent of about 18 acres, will be reclaimed from the sea, and will be filled in with material excavated from the bed of the harbour. The Afon Erch stream, which now flows into the harbour near the old railway station, will be carried through the reclaimed land by means of an open channel and discharge into the harbour.

The Cambrian Railways propose to extend their line along the new north embankment to a point near the Afon Rhyd Hir gates, where an extensive and commodious passenger station will be constructed. The old station will probably be reserved primarily for goods traffic.

The new line will cross the Afon Erch outfall by means of a bridge, a road bridge being also built alongside the railway bridge. The remainder of the land reclaimed on the north side of the harbour will be utilised for the construction of streets, quays, and houses.

Embankments will also be constructed extending from the existing railway station southward to the Saltings and from the southern side of the existing Cob embankment on to Morfa Gareg. Improvements and alterations will be carried out in connection with the Cob embankment rendered necessary by the deepening of the harbour.

The inner harbour will be dredged to a general level of 11 ft. below high water of ordinary spring tides, that is to say, at high water there will be 11 ft. depth over the whole of the inner harbour with certain minor exceptions. The material which is to be removed from the inner harbour to bring about this improvement will be utilised partly for filling in the reclaimed areas behind the embankment above referred to, the surplus being deposited in the centre of the harbour to form an island. It is the intention of the Corporation at some future date to make use of this island as a pleasure resort, the area amounting to eight acres, being laid out in gardens with attractive kiosks and band stands.

The water will be impounded or retained in the inner harbour to a certain fixed level by means of a long weir and tidal gates to be constructed across the narrow channel between Morfa Gareg and Glan-y-Don. The gates will be capable of admitting vessels of less than 34 ft. beam, and will give a depth of 15 ft. 6 in. over the cill at high water spring tides. The weir will retain the level of the water to a height of 6 ft. 3 in. above low water. It has been found impossible to further increase the height of the permanent water level on account of the difficulty that would be experienced in getting rid of the water brought down by the two streams flowing into the inner harbour, the level of these streams being considerably lower than high water level.

Certain portions of the bed of the harbour will be dredged to a level of 13 ft. below high water in order to provide a navigable channel to the quay.

A foot bridge will be constructed over the weir connecting Glan-y-Don and Morfa Gareg. Timber slips, stairs, and landing stages will be constructed in several positions within the inner harbour and on the island.

The outer harbour, that is to say, the portions of the harbour outside the proposed gates, and lying between them and the bar at Gimblet Point, will be dredged to a depth of 6 ft. below low water ordinary spring tides, for a maximum bottom width of 200 ft. Thus, at high water there will be a depth of 20 ft. 9 in. at spring tides.

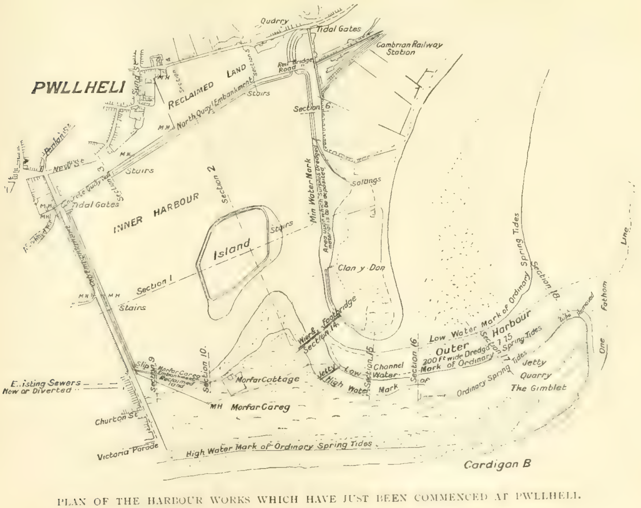
The outer end of the Gimblet Point formed by a long spur of stone *débris* will be removed to straighten the channel. This stone *débris* will be utilised to a certain extent in the construction of the pitched banks of the harbour works. A jetty will be constructed in the outer harbour at the Morfa Gareg side for the accommodation of fish traffic.

When the proposed works are completed, it will be possible for any of the fishing boats now frequenting the Cardigan Bay grounds to take shelter in the harbour of Pwllheli at any state of the tide. It is a surprising fact that at the present moment there is no harbour between Holyhead and Milford which does not practically dry at low water of spring tides. Pwllheli will will be in a position, on completion of the proposed works, to provide a depth of water at low water nearly 6 ft. greater than any other port in Cardigan Bay.

By the peculiar situation of the Gimblet Rock at Pwllheli, nature has provided a most admirable breakwater and protection to the harbour in all weathers.

In brief, practically all that is necessary for the provision of a safe and commodious harbour of refuge inside the Gimblet Point is to dredge the bed of the harbour and rivers and to maintain the dredged level. The actual removal of material which now prevents vessels of any draught from entering is a comparatively simple matter. The choice of means of maintaining a deep water channel when once provided presents a much more complicated problem. In this case the engineer has provided for the sluicing of the outer harbour by means of the vast quantity of impounded water maintained behind the new weir and gates. Occasionally, at low water of spring tides, the whole or at any rate, a large proportion of the whole of this water will be allowed to rush away to the sea, carrying in its progress through the outer harbour any undesirable deposit of sand or silt that may have accumulated during the preceding tides. The engineer estimates that the quantity of water thus available for sluicing purposes amounts to 57,000,000 gallons.

It is anticipated that the harbour works will be completed by the end of 1905. The engineer for the works is Mr. W. T. Douglass, M.Inst.C.E., of Westminster.



PLAN OF THE HARBOUR WORKS WHICH HAVE JUST BEEN COMMENCED AT PWLLHELI.

The Engineering Standards Committee
AND ITS WORK.

STANDARD DIRECT CURRENT PRESSURES AND STANDARD FREQUENCIES.

SINCE we last went to press a memorandum has been issued by the Committee appointed with reference to Standard Pressures for direct Current and Standard Frequencies. This section of the work of the Engineering Standards Committee, which is of importance to the electrical industry at large, was the first portion of the task entrusted to the special Committee on Generators, Motors and Transformers, by the Electrical Plant Committee.

The sub-committee consists of the following :—

Colonel R. E. Crompton, C.B. (Chairman), Colonel H. C. Holden, R.A., and Captain A. H. Dumaresq, R.E. (representing the War Office), Commander G. L. Sclater, R.N., and Mr. L. J. Steele (representing the Admiralty), Mr. Llewellyn Preece (representing the Crown Agents for the Colonies), Dr. R. T. Glazebrook (representing the National Physical Laboratory), Mr. B. H. Antill and Mr. W. B. Esson (nominated by the Electrical Engineers' Plant Manufacturers' Association), Mr. A. C. Eborall, Mr. S. Z. de Ferranti, Mr. Robert Hammond, Captain H. R. Sankey, Mr. C. H. Wordingham, Mr. Leslie S. Robertson (Secretary), and Mr. C. Le Maistre (Electrical Assistant Secretary).

At an early stage in their deliberations, the sub-committee decided that the most advantageous method of approaching this problem, beset as it is with so many difficulties, would be from the point of view of those most affected, namely the users of lamps, and of motors for power purposes. It was therefore agreed that the standard pressures to be suggested should be measured at the consumers' terminals as settled by the Act of 1899. At the present time there exist many different pressures declared by the various lighting and power authorities. In view of the great desirability of obviating this unsatisfactory state of affairs, it was deemed advisable to suggest the minimum number of standard pressures which would best meet present commercial requirements, and, at the same time, utilise to the fullest extent the consumers' existing appliances.

After careful consideration, it became evident to the sub-committee that the direct current pressures of 110, 220, 440, and 500 volts, would best meet the requirements, because carcases built for these standard pressures could be utilised for pressures 10 per cent. above or below the suggested standards, without any alteration whatever in the castings or mechanical components, by merely altering the windings and excitation.

It is to be hoped that now these direct current pressures have been fixed as standards by the committee they will in future be universally adopted by the engineers advising corporations and others distributing electrical energy. In course of time the benefits to the electrical industry at large, which will certainly follow the adoption of these standard pressures, must become more and more apparent.

A circular was drafted embodying the suggestions of the sub-committee, and this was submitted, first to the manufacturers for their consideration, and secondly to the leading consulting engineers and users of motors.

The information so courteously placed at the disposal of the sub-committee by the consulting engineers and manufacturers was most carefully weighed and considered by the sub-committee, and certain definite conclusions were arrived at, the circular being sent, in the first instance, to the manufacturers, as they were the people most directly interested. Replies were received from all the leading firms, who expressed themselves unanimously in favour of the recommendations of the sub-committee. The consulting engineers similarly gave their adherence to the proposals of the sub-committee.

Before coming to their final decision, the sub-committee on Generators, Motors and Transformers conferred with the sub-committee on Electrical Tramways, of which Mr. A. P. Trotter, is chairman, and a joint meeting took place, with the result that the pressure of 500 volts, which most concerned the latter sub-committee, was agreed to, and in addition to the pressures already agreed to, 600 volts was decided upon as the standard pressure for electrical railways.

The question of the adoption of standard frequencies, although of equal importance with that of standard pressures, was not surrounded with the same difficulties. It was, however, deemed advisable to fix upon the standard frequencies at the earliest possible stage of the work, as no progress could be made in the standardisation of prime movers for driving alternate current machinery until such time as the frequencies had been settled upon. On this question there appeared to be a great preponderance in favour of frequencies of twenty-five and fifty. The only point upon which any serious difference of opinion appeared to exist was the advisability of the adoption of a third frequency of forty or forty-two, to enable rotary converters to be used to the fullest advantage. All the arguments in favour of this third frequency were fully discussed, but after carefully weighing the *pros* and *cons* the sub-committee decided not to recommend the adoption of more than two frequencies, namely, twenty-five and fifty.

The recommendations of the sub-committee were then submitted to the Electrical Plant Committee, the Publication Committee, the Main Committee, and the Board of Trade for their approval.

This having been obtained, it was deemed advisable in the interests of the electrical industry of the country, that the findings on the questions of direct current pressures and frequencies should be published at an early date, without waiting for the completion of the entire report to be issued at a later date.

THE RESOLUTIONS.

The following are the resolutions :—

(1) That the standard direct current pressures measured at the consumers' terminals, be: 110, 220, 440, 500 volts.

(2) That the standard direct current pressures, measured at the terminals of the motors, be: For tramways, 500 volts; for railways, 600 volts.

(3) That twenty-five periods per second be the standard frequency for: (*a*) Systems involving conversion to direct current by means of rotary converters; (*b*) large power schemes over long distances; (*c*) three-phase railway work, where motor gearing and the inductive drop on the track rail have to be considered.

(4) That fifty periods per second be the standard frequency for: (*a*) Mixed power and lighting on town supply mains; (*b*) ordinary factory power plant; (*c*) all medium size power plant where rotary converters are not employed.

THE WORK OF THE ENGINEERING STANDARDS COMMITTEE.

It may be well to state briefly the scope and objects of the Engineering Standards Committee, and for this purpose we shall draw largely on the excellent epitome, which has been issued by the Secretary, Mr. Leslie S. Robertson. The importance of the work as affecting technical men need not be emphasised; it has already received the emphatic approval of the Government, who decided, some time ago, to vote a grant of £3,000 towards the necessary expenses. Sir Francis Hopwood, in communicating this decision to the Committee, stated that "the Board of Trade regards this work, including as it does the preparation of standard specification for engineering works, and of standard sections of rolled iron and steel, together with the standardisation of parts of locomotives and electrical appliances, as tending to reduce both the cost of the production and the time occupied in completion, and as being of the highest value to the country at large." Correspondence has recently passed between the India Office and the Secretary of the Engineering Standards Committee, with reference to a further grant in aid of the work, the outcome being a further contribution of £1,000. A conference took place between the manufacturers of locomotives for India and the four consulting engineers of the Indian Government, the result being a valuable report, which, it is confidently anticipated, will save the Indian Government considerable outlay in connection with locomotives required in future for the State railways.

The co-operation of the Government, however, has not been confined to financial assistance, valuable though that may be, but it has placed at the disposal of the committee many of its most able officers drawn from all the various Government Departments, and there are now more than twenty-four representatives of the Government on the various committees.

The Admiralty, who are one of the largest, if not the largest, users of rolled sections, have signified their approval in a most practical and valuable manner. Mr. Arnold-Forster, who throughout has taken a very keen and far-sighted interest in the work of standardisation, informed the House, shortly after the publication of the series of findings issued by the Committee, that the Admiralty had taken steps to give all orders for rolled material in terms of the findings of the Engineering Standards Committee. The loyal support of so important a Department as the Admiralty cannot but do much to hasten throughout the British Empire the adoption of standard sections.

It is to be noted that the Engineering Standards Committee is the outcome of a committee appointed by the Institution of Civil Engineers at the suggestion of Sir John Wolfe Barry, K.C.B., to inquire into the advisability of standardising rolled iron and steel sections. The Institution of Civil Engineers approached the Institution of Mechanical Engineers, Institution of Naval Architects, and Iron and Steel Institute, to appoint representatives on this committee, which commenced its labours in April, 1901. At a later date, on the suggestion of Sir William Preece, K.C.B., the question of the standardisation of electrical plant was added to the sphere of the committee's operations, and the Institution of Electrical Engineers was asked to co-operate with the kindred societies already supporting the committee. The five leading technical institutions are thus actively and financially supporting and controlling the operations of this important movement.

THE MAIN COMMITTEE.

This committee, under the chairmanship of Mr. James Mansergh, who was President of the Institution of Civil Engineers when the committee was formed, is responsible for the entire work of organisation, and approves the findings of the various committees as they are arrived at. The committee is as follows: Mr. James Mansergh (Chairman), Sir Frederick Bramwell, Bart., Sir Benjamin Baker, K.C.B., Sir John Wolfe Barry, K.C.B., Sir Douglas Fox, Mr. J. A. McDonald (Midland Railway), Professor Unwin (City and Guilds of London Central Institution), nominated by the Institution of Civil Engineers, Mr. E. Windsor Richards (Guest, Keen and Nettlefolds, Ltd.), Mr. William Dean (late Great Western Railway) nominated by the Institution of Mechanical Engineers, Mr. G. Ainsworth (Consett Iron Company), Mr. Arthur Cooper (North-Eastern Steel Company), nominated by the Iron and Steel Institute, Mr. Archibald Denny (William Denny and Bros., Dumbarton), nominated by the Institution of Naval Architects; Sir William Preece, K.C.B., Col. Crompton, C.B. (Crompton and Co.), nominated by the Institution of Electrical Engineers, Dr. Tudsbery (Hon. Sec.), Institution of Civil Engineers, Mr. Leslie S. Robertson (Sec.), 28, Victoria-street, S.W.

SECTIONS USED IN SHIPBUILDING.

A committee, under the chairmanship of Mr. Archibald Denny, has devoted its labours to this subject. Its object has been to decide upon a series of sections which on the one hand would give sufficient graduation, and would, on the other hand, not be larger than could be possibly avoided, so as to reduce to a minimum the plant and stock of rolls to be kept by the steel makers. The sections peculiar to shipbuilding are: bulb angles, bulb tees, bulb plates, and zeds, while the other lists have had to be framed not only to meet the requirements of the ships committee, but also of the other committees.

The above-mentioned committee on sections used in shipbuilding has for the time being concluded its labours in reference to standard sections. The question of "Tests" was next taken up, and to deal with this thorny subject the committee was considerably strengthened by the addition thereto of representatives from both the shipbuilding and machinery sections of the industry.

This committee is deliberating upon the most suitable tests to be applied to materials used in the construction of ships and their machinery, with the object of arriving at a common basis of agreement between the many divergent specifications and restrictions at present in vogue.

BRIDGES AND GENERAL BUILDING CONSTRUCTION.

The Bridges Committee is presided over by Sir Benjamin Baker, K.C.B., and upon it are represented the Government departments directly affected, the large bridge constructors and the producers of materials used in bridges and general building construction. Their labours have been confined principally to drawing up a series of standard beams and tees, and to the consideration of "equal and unequal angles," so as to meet all the requirements of general building construction. The standard list of beams includes only thirty sections—a considerable reduction from the large number formerly in vogue.

It is a noticeable feature that some of the leading firms have already informed their customers that they are re-turning their rolls to comply with the new standard list issued by the committee.

RAILWAY ROLLING STOCK UNDERFRAMES.

The committee which has this work in hand is presided over by Sir Douglas Fox, and contains representatives of the railway companies and of the leading firms occupied in the construction of railway rolling stock. It has been considering the list of sections used in railway rolling stock underframes, more particularly those of channels and angles.

COMMITTEE ON LOCOMOTIVES.

This committee is presided over by Sir Douglas Fox. This subject in so far as India is concerned, has been officially referred to the committee by the Secretary of State for India. The work is divided among four sub-committees: (1) Component parts and types; (2) Steel plates; (3) Tyres, axles, and springs; (4) Copper and its alloys. The sub-committee on component parts and types is presided over by Mr. Wolley-Dod, the Chairman of the Calcutta Conference recently appointed by Lord George Hamilton. This committee is engaged in drawing up a series of standard types of locomotives for India, both broad and narrow gauge. The sub-committee on steel boiler plates for locomotives is presided over by Mr. Lorimer, the Chairman of the North-British Locomotive Company, Ltd., and is dealing with the question of a standard specification for locomotive boiler plates.

The sub-committee on copper and its alloys is presided over by Mr. Dean, formerly chief locomotive superintendent of the Great Western Railway, and has on its roll representatives of the leading railway companies, large locomotive builders, and producers of copper plates. It is engaged in drawing up a standard specification for copper plates and rods used in locomotive construction.

COMMITTEE ON RAILS.

The committee on this important subject is presided over by Sir John Wolfe Barry, to whose insight and business ability this whole movement is largely due.

The work of the committee is divided into two sections—(*a*) railway rails, and (*b*) tramway rails. The former, presided over by Mr. Inglis, chief engineer to the Great Western Railway, consists, mainly, of the permanent-way engineers of many of our largest railways, and representatives of the leading manufacturers. This sub-committee has been engaged in drawing up a series of standard flat bottom rails, standard bull headed rails and standard specifications for the same. The bull-headed rails commence at 60 lb. per yard, and rise by increments of 5 lb. to 105 lb. per yard. The flat bottom rails commence at 20 lb. per yard, and rise by steps of 5 lb. to 110 lb. per yard.

The sub-committee on tramway rails is presided over by Mr. Howard-Smith, a gentleman who has given much attention to this branch of the subject. The sub-committee have already agreed upon a series of standard tramway rails from 90 lb. to 110 lb., advancing by 5 lb. at a time, and these have been finally approved by the Board of Trade. (See PAGE'S MAGAZINE for October.)

COMMITTEE ON ELECTRICAL PLANT.

This committee is presided over by Sir William Preece, and consists of the representatives of the various Government Departments and the leading consulting and manufacturing electrical engineers in the country. The committee has held many sittings to hear evidence as to the advisability of issuing standards for electrical machinery, and as to the direction in which the committee could render the greatest service to the electrical industry of Great Britain. At the termination of the evidence it was decided to form sub-committees to deal with the various sections of the work, and four sub-committees were formed to take up the subject of (1) generators, motors and transformers; (2) temperature; (3) cables and conduits; (4) telegraphs and telephones.

The sub-committee on generators, motors and transformers is presided over by Colonel Crompton, C.B., and is occupied in collecting evidence as to how far standardisation can be introduced in the construction of dynamos, generators and transformers, and the materials of which they are composed.

The sub-committee on temperatures of insulating materials is presided over by Dr. Glazebrook, the Director of the National Physical Laboratory, and is engaged in a most interesting series of experiments to determine the ability of different insulating materials to withstand heat, together with the deteriorating effect produced by submission to heat over long periods.

The sub-committee on cables and conduits is presided over by Mr. Robert Kaye Gray, the President of the Institution of Electrical Engineers, and is dealing with the subject of the standardisation of cables and of underground conduits other than tramway conduits.

The sub-committee is composed of the official representatives of the Cable Makers' Association, the various Government Departments and others who are large users of cables. It is engaged in drawing up a series of standard tables in connection with cables, and the result of its deliberations should considerably simplify and cheapen the manufacture of cables in this country.

The sub-committee on telegraphs and telephones is presided over by Mr. Gavey, the engineer-in-chief to the Post Office, and is occupied in the preparation of standard tables and specifications for wires and other matters directly concerning the construction of telegraphs and telephones.

Sub-committees have also been appointed to deal with screw threads and limit gauges. They are presided over by Mr. H. F. Donaldson, chief mechanical engineer to the Royal Arsenal at Woolwich.

OTHER COMMITTEES.

Committees have also been appointed to deal with the questions of Pipe Flanges (Chairman, Mr. W. H. Maw), Cement (Chairman, Mr. W. Matthews, C.M.G.), Publication and Calculations (Chairman, Mr. Maxam Ende), Finance (Chairman, Mr. James Mansergh).

It may be mentioned that the French Government have sent over a Commissioner to study the procedure, and the lines upon which the Engineering Standards Committee has been organised. Surely no greater compliment could be paid to its efficiency.

BOOKS OF THE MONTH.

"A TEXT-BOOK OF APPLIED MECHANICS AND MECHANICAL ENGINEERING."

Specially arranged for the use of engineering students qualifying for the Institution of Civil Engineers, the Diplomas and Degrees of Technical Colleges and Universities, Advanced Science Certificates of British and Colonial Boards of Education, and Honours Certificates of the City and Guilds of London Institute, in Mechanical Engineering. By Andrew Jamieson, M.Inst.C.E. Volume I. 4th edition and Volume II. 3rd edition. Charles Griffin and Co., Ltd. 8s. 6d. net. each.

THE utility of this comprehensive work has been greatly enhanced by many important additions, more particularly with regard to the application of electricity to the driving of tools and cranes, and students who contemplate sitting for the half-yearly examination of the Institution of Civil Engineers should be grateful to Professor Jamieson for so carefully studying their requirements. The various questions contained in the examination papers of the Institution upon mechanics, structures, strength and elasticity of materials, as well as hydraulics, have been referred to the respective lectures and appendices covering them. As the author says, he has not forgotten the requirements of either those who desire to pass the Advanced and Honours Applied Mechanics Examinations of the Boards of Education for England, Scotland and Ireland, or those preparing for the Mechanical Engineering Examinations of the City and Guilds of London Technological Institute, for their examination questions have been allocated in the same way with the 1903 papers and rules. Altogether, volume I. has about 300 figures and diagrams, with a new frontispiece, showing the 130-ton steam crane erected at Glasgow Harbour, together with more than 500 questions, while in volume II. there are over 350 illustrations and 950 questions. Among the contents may be mentioned Tables of Symbols and Abbreviations; Construction, with notes on oiling of Heavy Shaft Bearings, and the Seigrist System of Automatic Lubrication for Large Engines, by J. L. Graham; Examples on Speed and horse-power from Resistance of Models and full-sized Steamships, by John Anderson; Kynoch Roller Bearings, Hoffman Ball Bearings, Humber Cycle Ball Bearings, and Lea-Francis Clutch Ball-race; Heenan and Froude's Water Dynamometer, together with the Applications of Froude's Dynamometer, by Professor Weighton, at Durham College of Science; Speed-reducing Worm Gear, by David Brown and Sons, Huddersfield; Cable Grappling, Picking-up and Paying-out Gear; Changing Speed with Electro Motor Connections; Machine cut Gearing; Correct Form of Bevel Wheel Teeth; Wüst Double Helical Gear, by Marryat and Place, London; Speed-Reducing Gear, by R. G. Ross and Sons, Glasgow; Amsler's Planimeter, as used for Measuring Engine Indicator Diagrams and other Irregular Figures; Thunderbolt's Marine and other Steam Engine Governors; Hercules Turbine Installation and Pneumatic Tools, by John Turnbull, jun., and Sons, Glasgow; Water Turbines and Rules for Hydraulic Motor Installations, by J. Ritchie, of Carrick and Ritchie, Edinburgh, etc. Professor Jamieson handles his subject in a manner which cannot fail to lighten the labours of the student, and the careful manner in which question and answer are presented, offer only one phase of the thorough workmanship which obtains throughout the volumes.

"THE UNIVERSAL ELECTRICAL DIRECTORY, 1903."

Edited by J. A. Berly. 10s. British Colonies, 12s. Other Countries, 13s. H. Alabaster, Gatehouse and Co.

THIS well-known and reliable work of reference, which has reached its twenty-second year of publication, can claim to be the largest as well as the oldest, and we may add, the most complete, electrical directory issued. It comprises the names of the members of the electrical and kindred industries throughout the world.

The book has been most thoroughly revised, and the British alphabetical section now comprises about 11,080 distinct names; the Continental alphabetical section, about 9,405 distinct names; the United States alphabetical section, about 7,040 names; and the Colonial and general alphabetical section, about 3,465 distinct names; a total of 30,990.

For simplicity and facility of reference it is divided into four groups, namely: British, Continental, United States of America, and Colonial and General, which are again sub-divided into alphabetical and classified sections; in the British Group a Geographical Section is given, making in all nine subdivisions. In addition to the new names incorporated in the present issue, much financial information is given, the telegraphic addresses and local telephone numbers are included, and the pages added to the work are 81 in number as compared with that of 1902, making in all 1,350 pages entirely of directory matter. The lists of central stations in the United Kingdom and Colonies have again been considerably added to, and the engineers' names, system of distribution in use and the voltage have been included.

"GAS AND OIL ENGINE MANAGEMENT."

A Practical Guide for Users and Attendants, being notes on selection, construction and management. By M. Powis Bale, M.I.Mech.E., A.M.Inst.C.E. Crosby, Lockwood and Son. 3s. 6d. net.

WRITTEN on similar lines to the author's "Handbook for Steam Users," this work should be of considerable interest to those who are called upon to select gas and oil engines, as well as to those whose business it is to attend to them. A feature which commands our admiration is the arrangement of the paragraphs, which have large type headings, and are admirably set out for easy reference. With regard to the selection of an engine, the author remarks that each case should be judged on its merits; the chief points to be considered are: (1) the nature and calorific value of the gas to be used; (2) the speed, duty and power required of the engine. But as the design and details of construction would necessarily vary considerably, an untechnical reader would do well to take the advice of a competent engineer before deciding for himself. An engine of a size showing a fair margin of surplus power over the work to be done should be chosen, as, unlike a steam engine, it cannot be pressed beyond its ordinary full working load when extra power is required; and no gas or oil engine should be run at its maximum horse-power for lengthened periods.

"METALLURGICAL ANALYSIS AND ASSAYING."

A Three Years' Course for Students of Schools of Mines. By W. A. Macleod, B.A., B.Sc., A.O.S.M. (N.Z.) and Charles Walker, F.C.S. Charles Griffin and Co., Ltd. 12s. 6d. net.

THIS work chiefly appeals to us by reason of its careful arrangement and its completeness. It provides for the student a graded course of work, ranging from simple qualitative analysis to the technical quantitative analysis of the modern metallurgical chemist. The time necessary for a student of average ability to cover the ground is thus set forth :—

PART I. (First year.)	Qualitative Analysis and Preparation of Gases, 9 hours per week for 11 weeks and 6 hours per week for 22 weeks, or a total of 231 hours.
PART II. (Second year.)	Advanced Qualitative Analysis, 3 hours per week for 33 weeks. Quantitative Analysis, 12 hours per week for 33 weeks, or a total of 495 hours.
PART III. (Third year.)	Assaying, 16 hours per week for 33 weeks. Technical Analysis, 8 hours per week for 33 weeks, or a total of 792 hours.

The author considers it highly advisable, however, that the student extend the course to a fourth year.

"GOVERNORS AND GOVERNING MECHANISM."

By H. R. Hall. The Technical Publishing Company, Ltd. 2s. 6d net.

A CLEVER and comprehensive treatise showing almost at a glance the principles which underlie the action of a steam governor and the qualifications that a governor should possess. The latter are thus set forth : (1) Power, and to possess this, it must be static, or be a one-speed, one-position governor, and not a one-speed any-position governor. (2) Sensitiveness, *i.e.*, the difference in speed between the two extreme positions should be small. (3) Regularity, *i.e.*, the differences in speeds between any two equal intermediate positions should be alike. (4) Steadiness, and (5) Lightness, which, though not an essential quality, is still a very desirable one. The author shows that the sensitiveness of a governor depends on the degree in which it possesses the first and third of these properties, viz., power and regularity, and not on its approximation to isochronism as is generally supposed.

"THE SLIDE RULE."

A Practical Manual By Charles N. Pickworth. Eighth Edition. Emmott and Co., Ltd., Manchester and London. D. Van Nostrand Company, New York. 2s.

THE eighth edition of this well-known manual has been enlarged by sixteen pages, and now includes the Principle of Log.-Log. Scales ; The Davis Log.-Log. Rule ; The –E Scale ; Use of Log.-Log. Scales for determining Logarithms to any Base ; The Perry Log.-Log. Rule ; The Faber Log.-Log. Rule ; The Radial Cursor and its Applications ; The Goulding Cursor ; The Magnifying Cursor ; Faber's Digit Registering Cursor ; The Solution of Quadratic and Cubic Equations ; Sectional Length or Gridiron Slide Rules ; Constructional Improvements in Slide Rules ; Hall's Nautical Slide Rule, etc.

"THE ELEMENTS OF MACHINE DESIGN."

By W. Cawthorne Unwin F.R.S., etc. New edition, Part II. Revised and Enlarged. Longmans. 6s.

THE second part of Professor Unwin's work, in the familiar cover of Messrs. Longman's Text-books of Science series, is chiefly devoted to engine details. In the light of more recent research, the present edition has been largely rewritten. It is excellently adapted as a reference book for draughtsmen and text-book for students. The following is a synopsis of contents : Properties of Materials ; On Pipes and Cylinders ; Arrangement and Proportions of Steam-engine Cylinders ; Indicator Diagrams ; On some Kinematical and Dynamical Problems in Engine Designing ; Balancing Cranks, Levers, and Eccentrics ; Connecting Rods ; Crossheads and Slides ; Piston and Piston Rods ; Stuffing-boxes ; Flywheels ; Valves, Cocks and Sliding Valves ; Valve Gears ; Valve Diagrams ; Expansion Valves ; Link Motions and Reversing Gears ; Lubricators.

"THE ELEMENTS OF ELECTRICAL ENGINEERING."

A First Year's Course for Students. By Tyson Sewell, A.I.E.E. Second edition, revised, with 274 illustrations. Crosby, Lockwood and Son. 7s. 6d. net.

To Mr. Sewell's valuable work, three chapters have been added in the present edition, dealing with alternating currents, and the author has also included an appendix of questions, which students should find extremely useful in testing their progress. It may be mentioned that the volume is based upon a series of lectures which were originally delivered to students desirous of qualifying as electrical engineers. As far as possible, the subject is treated on easy and non-mathematical lines.

"THE MANUFACTURE OF IRON AND STEEL TUBES."

By Edward C. R. Marks. Second and Enlarged Edition. The Technical Publishing Company, Ltd. 5s. net.

A USEFUL summary of the past efforts and achievements of inventors in this field, based upon their specifications. This work is developed from a special course of lectures delivered at the Birmingham Municipal Technical School. The work has been brought up to date, and the list of patents given as an appendix has been revised.

"THE ARITHMETIC OF ELEMENTARY PHYSICS AND CHEMISTRY."

By Harold Munkman Timpany, M.Sc. (Vict). Blackie and Son, Ltd. 1s.

STUDENTS in physics and chemistry will find this a useful addition to their books, as it gives special and careful attention to a branch of study which is often puzzling to beginners. Question working and answer are clearly set forth, and a fairly wide range of problems has been covered.

BOOKS RECEIVED.

Notes on the Material, Construction and Design of Land Boilers. By Edward G. Hiller, M.Inst.C.E., M.I.Mech.E., embodying the practice of the National Boiler and General Insurance Company, Ltd. Published by Taylor, Garnett, Evans and Co., Ltd. Price 1s., bound full cloth, 1s. 6d.

Chemical and Metallurgical Society of South Africa. Proceedings. Volume II. 1897–1899. Published at 21s. net, and may be obtained either from the publisher, Mr. R. W. Hunter, 19, George IV. Bridge, Edinburgh ; the "Engineering and Mining Journal," 261 Broadway, New York ; or from the Secretary of the Association.

A number of reviews are unavoidably held over.

The Preservation of Wood from Fire and Decay.

BY

SIR RALPH MOOR, K.C.M.G.

In the previous article, Sir Ralph Moor, K.C.M.G., who has made a special investigation of the Ferrell processes, gave a brief account of the circumstances which have led to their development. The inventor, Mr. Joseph M. Ferrell, of Philadelphia, has devoted many years to this problem, and his inventions recently earned for him the Elliott-Cresson Gold Medal of the Franklin Institute. In the previous article, the author discussed the various chemicals employed; he now proceeds to describe their application to the timber.—Ed.

II.

We have seen that after exhaustive experiment sulphate of aluminium was determined as the principal chemical substance for employment in the Ferrell solutions—not that it met all the essential requirements, but it was found that in conjunction with other chemicals it could be made to meet them fully, and in this way by careful and exhaustive experiment the solutions were determined. We now come to the methods of application. The first point to consider here is as to the necessity of any preliminary treatment of the timber itself to render it fit to be put through the actual processes. This concerns principally the sap question, and Mr. Ferrell, the inventor, made a critical study of this, with the result that he has differentiated as between the actual sap which promotes the growth and gives life and strength to the tree, and the sap water which is merely the vehicle conveying the sustenance. The sap itself is essential to the structural strength of the tree, and any attempt to remove it must damage the mass in this direction. On the other hand, the sap water is a vicious and undesirable element which has a tendency to generate germs and consequently decay, so that any system to be effective must remove or effectually neutralise it. Having arrived thus far, it was evident that wood could be treated equally well whether in a green or seasoned state, if only during the process the sap water were driven out or neutralised by such deposit within the cells and pores of the timber of a chemical substance as would be an effective germicide. The sulphate of aluminium used is such a substance, and it may be mentioned that its properties can be fully studied in a work on "The Manufacture of Alum and the Sulphates and other Salts of Alumina and Iron," by Lucien Geschwind, published by Scott, Greenwood and Company.

SATURATION UNDER THE OLD SYSTEM.

It being thus determined that no preliminary treatment is necessary, the next step is to provide means to effect a thorough saturation of all classes of wood with the various solutions, whether against fire or decay. Dealing first with the saturation against fire of timber generally, the inefficacy of the original mechanical apparatus has already been referred to, and Mr. Ferrell, a mechanical engineer by profession invented a new and thoroughly effective apparatus. The old form of apparatus still in use consists of a cylinder of from 62 in. to 84 in. diameter and from 85 ft. to 112 ft. long, closed at one end and having a massive door at the other, swinging either horizontally or lifted vertically. This door is fastened by a multi-locking system of belts passing through locks on the periphery of the cylinder. It is obvious that an external joint of from 62 in. to 84 in. diameter which has to be opened say once or twice every twenty-four hours, presents a practical difficulty of great significance when it is desired to make it absolutely tight against any considerable pressure from within. If it leaks badly no uniform pressure can be maintained. Further, a perfect saturation even of 1 in. thick white pine boards cannot be effected in any reasonable time unless a pressure of at least 175 lb. is applied, and it then requires several hours, no matter what preliminary process may have been employed. If large leakage occurs the pressure pump must make it up, and in so doing its reciprocating shocks delivered against wood whose exterior surface has been softened by previous steaming in preliminary treatment, exerts a most damaging and disastrous effect. From all published descriptions it appears that saturation of boards and planks by this old system requires from twenty-four to forty-four hours.

THE NEW PROCESS.

The new Ferrell method which, as before stated, wholly abandons all preliminary processes, having determined by practical tests that they are erroneous in principle, uncalled for, enormously expensive and practically deleterious, effects saturation by a mechanical apparatus in from fifteen to sixty minutes according to the size of timber treated. The mechanism is composed of a cylindrical body 50 in. in diameter and 112 ft. in length, made of cast steel flanged sections 2¼ in. in thickness, with a special hydraulic joint at the flanges capable of enduring hydraulic pressure of 1,000 lbs. per square inch. At each end is a domed gate with a vertical hydraulic cylinder superimposed which operates a vertical gate valve weighing five tons. The gate is provided with phosphor bronze rings as also the inner and outer guide surfaces. When the internal operating pressure comes upon the gate, these ring surfaces coincide and the joint is perfect whether with 10 lb. or 1,000 lb. pressure. The greater the pressure the tighter the joint. This is the reverse of the old externally applied gate. Further, all possibility of communicated shock from the pressure pump is obviated by the interposition of a hydraulic accumulator loaded to the nominal saturating pressure of each kind of wood. This pressure has been determined by Mr. Ferrell by exhaustive experiment to be as follows :—

White pine	300 lb.
Yellow pine	350 ,,
Ash	400 ,,
Chestnut	400 ,,
Beech, birch and maple . .	450 ,,
Oaks	650 ,,

The direct saturation in this machine of planks of 1 in. thickness of these woods can be performed under these pressures because of the absorption of shock from pressure pump with perfect results to the wood, and in a small fraction of the time required by the old system. The wood is taken as it comes from the source of supply, put into the cylinder, the gate is closed, the cylinder is run full of saturating liquid, pressure is applied, the liquid is returned to the tanks, the lumber is run into a dry kiln and another charge of lumber is run into the cylinder.

The treatment of large timber and railway ties is effected in a mechanical apparatus similar to the foregoing with slight adjustments. It has a gate at only one end and is closed at the other. At this latter end there is a heavy cast-iron pad, in the centre of which is inlaid a heavy rubber ring. This pad is attached to a hollow arm which passes through a stuffing box at the back end. Back of the pad, a portion of the hollow arm is threaded, and this threaded section works through a fixed block correspondingly threaded, thus giving a positive traverse forward and back of the rubber inlaid pad. A 3 ft. wheel is keyed on to the outer end of this arm. Through the wheel a small pipe projects which is connected with the supplying line from the hydraulic accumulator. The operation consists in raising the gate in front hydraulically. On the inside of this gate is another inlaid rubber ring corresponding with the one on the pad at the other end. The timber is run into the machine, the gate is dropped. The wheel at the back head being revolved forces the rubber ring inlaid pad against the centre of the tie which sets it up in turn solidly against the inlaid rubber ring at the outer end in the gate. It will thus be seen that the centre of the timber at each end is set up solidly against a rubber joint.

Now there is a valve in the gate opposite the centre of the timber at that end, and an opening through the pad in centre of inlaid rubber ring at the other end through which liquid under pressure is supplied from the accumulator. The small valve in the gate opposite the centre of the timber is left open and the liquid under pressure is admitted through the centre of the pad. That liquid rapidly passes longitudinally through the timber and finds its exit through the valve in the gate. If there is water in the wood it will come out ahead of the liquid but will soon be exhausted and the solution of full strength will follow.

The small valve in the gate is now closed, but pressure on the solution entering the timber at the other end kept up ; the natural traverse of the liquid is radial to its longitudinal exit and it goes out through the medullary rays to the surface of the timber finally and thoroughly. Experience shows that this can be done on an average in seven minutes in the case of timbers of the size of railway ties. The cylinder is now filled with another chemical solution, enveloping the whole superficies except the parts in the centre of ends, which, under necessary pressure, mingles in the timber with the first and produces a double chemical decomposition, filling the cells of the wood with insoluble chemical compounds, which are permanently embodied in the mass and cannot seep out under any weather conditions.

IMBIBITION PROCESS.

Another method of application of the solutions for treating wood to render it fire resistant, and also as against decay when for internal use is by the imbibition process. A large cement tank with copper heating tubes, a proper cover and the necessary heating apparatus is all that is required for this purpose. The timber is stacked in the tank, which is then filled with the solution. The solution is raised by the heating tubes to about boiling point, at which it is maintained for one hour. After from eighteen to twenty hours' soaking the solution is drawn off into another tank, and the first tank then acts as a drying kiln by using the heating tubes at regulated temperature, thus drying out the water of chemical solution, and leaving in the wood cells and pores the chemical substance conveyed by it, which is non-volatile. This method of application is distinctly cheaper than the mechanical one, but the time necessary is considerably longer.

FILLER AND SURFACE COATING.

The solutions for " Filler " and " Surface Coating " have only just emerged from the experimental stage, and applications for patents have lately been made. It is therefore impossible at the moment to enter into the details of their composition, but careful inquiry has determined that the cost of the ingredients is so low that these solutions can be manufactured at such a rate as to stand the cost of transport, and at the same time be sound propositions commercially. In arriving at these discoveries a new set of phenomena had to be dealt with.

All existing paints are for superficial treatment, and have little or no penetrative power. They are consequently only surface applications, having no bond with the body of the wood. On exposure to heat, such paints break up sooner or later, scale off or otherwise disappear. The oil vehicle in their composition is of a combustible nature, and consequently adds to the danger from fire ; also it cannot be regarded as a sound preservative against decay. There are many fire-proof paints on the market, but the small results accruing from their application cannot be regarded as encouraging. After arduous and careful experiment a chemical substance was discovered of extraordinary penetrative power, and the principle guiding the experiment was as in the other treatments—a massing in the cellular structure of the wood, as far as penetrable by the substance, of a chemical that should withstand both fire and decay. Subsequent coatings of other chemicals making union with the first, create an actual bond in the body of the wood, ensuring adhesion and condensation; an enamel—not a paint—grows upon the wood surface, possessing fire resistance over six times on the average that of wood treated by sulphate of ammonia solution diffused throughout the entire wood body.

The problem involved the discovery of a transparent enamel for hard and fine woods in interior work. It compelled the discovery of means of application to woods covered with old paints and old varnish, the ability to absorb and receive on its surface lead or zinc paints when required, and finally the means of incorporation of all shades of colouring in the massed enamel in such a manner as to be proof against wear of weather exposure, and by such incorporation to preserve indefinitely the original freshness and brightness of the colouring matter. The "Filler" and "Surface Coating" arrived at by Mr. Ferrell have fully met all these points, a single application of the former penetrating below the surface of oak one-quarter of an inch. Subsequent coatings of the latter make a chemical union with the former, thus creating an actual bond, and practical test has shown that they can be made the vehicle for any colouring matter required. Experiment has further shown that they can be employed either under or over other paints and varnish with equal efficacy.

The results of the foregoing treatments, either of timber for future use or of timber in existing structures, have been shown to produce unquestionable non-inflammability. It thus becomes a determined fact that wood so treated sustaining no flame itself, can communicate no flame, and attacking flame can endure only so long as its original fuel supply remains unconsumed. Therefore a fire originating in untreated contents of a structure will consume such untreated contents and may blacken and roughen the surface of the structural wood so treated, but it can never excite any flame therein.

The result of experiments I made personally, using a Bunsen burner, showed that plain untreated timber took fire almost immediately on the application of the flame, and succumbed in from twenty-five to thirty-five minutes, being in such a state as to convey fire during the whole period. Timber treated by so-called Fire Proof Wood Companies withstood flame, but eventually succumbed in from sixty to seventy minutes, being during the latter part of the time in a state to communicate flame. The samples treated by the Ferrell processes, by saturation, and those dressed with "Filler" and "Surface Coating," withstood disintegration for a period of from 480 to 500 minutes, were fire-resistant during the entire period, and showed neither flame nor incandescence from which fire could be communicated.

COST.

The question of cost is a most important one, and this I entered into with great care. The cost of the chemical ingredients for the Ferrell processes I determined by actual purchase and independent inquiries. The strength of solutions and the quantities of chemicals to obtain it I determined by experiment, as also the amount of absorption of the solution to effect the necessary saturation. This latter was determined by weights of the samples treated, both before and after saturation, from which gallonnage absorbed is calculable, and thence the actual cost of chemicals.

The calculation arrived at gave the approximate cost of treating timber mechanically, or by saturation, to be 45s. to 55s. per thousand superficial feet of one-inch planking, taking the average of all timbers treated. The cost of the "Filler" and "Surface Coating" I have already dealt with, and there is no doubt that they can be manufactured at very low rates, from inquiry into the cost of ingredients and actual experiments in mixing.

It will be gathered that the cost of actual treatment by the Ferrell processes, taking into consideration the duration and methods of them as before described, is distinctly low, and, as far as I have been able to ascertain, fractional as compared with other processes. The cost of actual chemicals employed in the existing methods is also, as far as I have been able to ascertain, high in comparison with the cost of substances employed in the Ferrell solutions.

EXAMINATION BY EXPERT CHEMISTS.

An experimental treating plant will, in all probability, be erected in this country at no distant date, and in the meantime expert chemists are examining the processes scientifically.

I may add in conclusion that this question is one of vast importance to Insurance Companies, and that experts at the Insurance Engineering Experimental Station in Boston have for some time carried on exhaustive experiments in testing the so-called fire proof woods now produced and employed in construction in America. The resulting expert opinion is to the effect that the treated woods now in use which have been so tested do not come within such measurable distance of ensuring practical immunity from fire as to justify special insurance rates where they are employed in construction. The Ferrell processes are about to be tested at this station, and the Director in writing of them after making personal inquiries, says:—"We may now feel great confidence that wood has been made resistant to flame, fire and heat for a long number of hours," adding, at the same time, "I have been seeking and hoping for such a process for more than twenty years, long since rejecting the treatment with ammonia which lately came up, especially in New York, and misled so many people. I want to be able to say that a fire resistant wood is in sight after twenty-five years' search for such wood in my practice as Mutual Underwriter."

SAFETY MINING LAMPS.

BY

RUFUS J. FOSTER.

The author shows briefly the functions of the safety lamp and details the circumstances under which it was invented. He states what he conceives to be the requisites for a good lamp for general use, and summarises the distinguishing features of the various types employed. Lamps used for testing purposes are also described.—ED.

IN coal-mining operations the necessity for safety lamps is due to the presence of light carburetted hydrogen, CH , or marsh gas, in the mine atmosphere. This gas is generally designated as "fire damp" by the miners. It rarely happens that the gas is found in a pure state in the mines. It often contains admixtures of other gases, such as carbonic-acid gas, CO_2, and carbonic-oxide gas, CO.

The term "fire-damp," as used by miners, means also such an admixture of light carburetted hydrogen and air as will form an explosive mixture. Pure marsh gas, or light carburetted hydrogen, is colourless, odourless, and tasteless, and is lighter than air. Its specific gravity is ·559, and it diffuses rapidly in the air and forms a "fire-damp" mixture. It burns with a blue flame, but will not support combustion. Pure marsh gas, or light carburetted hydrogen, is not poisonous, but it will cause suffocation, because it excludes oxygen from the lungs.

NATURE OF EXPLOSIVE GASES.

Owing to its light specific gravity, marsh gas, or the fire-damp mixture, always lodges against the roof of a mine, or seeks the higher places. It has been a serious and dangerous obstacle to the mining of coal since the very infancy of the industry.

As stated previously, pure marsh gas, when present in small quantities in the air, burns in the flame of a lamp without explosion. As the quantity of the gas is increased, the effect on the flame of the lamp is at once noticeable. As the proportion of gas in the air is further increased, and approaches the lower explosive limit, the lamp flame enlarges, snaps and crackles. When the proportion of gas to air is 1 to 13 slight explosions occur within the lamp, the flame of the lamp jumping violently. As the proportion of gas is increased, the violence of the explosion is augmented, until it reaches a maximum when the proportion of gas to air is 1 to 9½ (exactly 1 : 9·38). This is the proportion of gas and air in fire-damp when at its maximum explosive point. From this point, as the quantity of gas is still further increased, the violence of the explosion decreases, until it becomes very feeble when the proportion of gas and air is 1 to 5½, and ceases altogether beyond this point. These limits refer to a fire-damp mixture, consisting of pure marsh gas and air.

For many years the European coal miners regarded explosive gases in mines as supernatural manifestations and as expressions of the displeasure of the goblins at man's presumptuous invasion of their domains. The same idea prevails in China to-day, and it is still a common practice in that country to abandon a coal mine after an explosion, for fear of further angering the dragon spirit.

EARLY PREVENTATIVES.

An examination of the mines before the miners went in to work was practised in England in a very crude way as early as the middle of the fifteenth century. A dog lowered down the shaft would howl when it entered the fire-damp; it was then withdrawn and the gases cleared away by running a brush tied to a rope up and down the shaft. In Staffordshire a fire boss is still called a doggie.

Candles and various forms of lamps were early used for lighting the mines, and when the working places became so foul that such lights could no longer be used, skins of putrid fish were hung up and their slight phosphorescence enabled the miner to barely make out the face of the coal. This custom probably suggested the idea of using luminous paints in the mines, tried subsequently, and it developed later into the present very common practice of whitewashing portions of the mine to aid in the illumination.

By the year 1800, steel mills had come into general use in England for lighting mines, and, though safer than candles, many explosions resulted from their use.

These mills were operated by boys, usually the sons of the miners, each miner taking his boy into the mine and requiring him to almost continually turn the wheel with one hand while he held a piece of flint against the wheel with the other. The resulting shower of sparks, while a beautiful pyrotechnic display on a small scale, gave but little real light.

During the early years of the nineteenth century the ever-recurring disastrous explosions throughout Great Britain made a great impression upon the Rev. John Hodgson, a clergyman of the North of England. At that time the newspapers did not publish accounts of explosions in the mines, and they were given as little publicity as possible, so as to avoid giving offence to the colliery owners. The Rev. Mr. Hodgson, however, in the face of public opinion, gave an account of a serious explosion which occurred at the Felling Colliery, May 25th, 1812, by which ninety-two men and boys were killed, and after this in every possible way he directed public attention to the subject of mine accidents.

SIR HUMPHRY DAVY'S EXPERIMENT.

These public notices attracted the attention of Mr. J. J. Wilkinson, a Barrister-at-Law, of London, through whose efforts the "Society for the Prevention of Colliery Accidents" was formed October 1st, 1813. Soon after the formation of this society, the assistance of Sir Humphry Davy was solicited to solve the problem; but the letter inviting his assistance miscarried, and it was not until three years later that the matter was brought to his attention. Sir Humphry at once reviewed all that had been written on the subject, and then visited the mines of the North of England, where he studied the practical considerations connected with the use of lamps about the mine and consulted with mine operators. Mr. Hodgson made known to him a theory that the fire-damp came from the coal itself and not from the decomposition of the coal or the water or of the pyrites, as was commonly supposed. Sir Humphry Davy immediately went into the dining-room of Mr. John Buddle, with whom he was staying, and broke some pieces of coal under water, when gases were seen to bubble up through the water, thus showing that Mr. Hodgson's ideas were probably correct. Sir Humphry next visited Dr. Clanny and inspected a lamp he had made; then returned home and immediately began his experiments, which from the first were encouraging. He soon discovered the action of wire gauze upon a flame, and early in January, 1816, only about five months after he began his investigations, sent three "Davy's" to Newcastle, where they were first tested at the surface and then underground, and during the same year they came into general use throughout the North of England. Although, of course, modified in its details, the present Davy lamp is entirely similar to these first sent out by Sir Humphry Davy.

DR. CLANNY.

Although Sir Humphry Davy invented the first practical safety lamp, the honour of first suggesting a method for insulating mine lights belongs to Dr. Clanny, a physician of Sundaman, England. Late

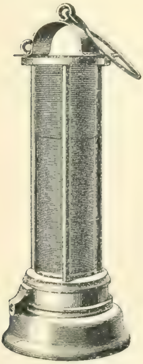


FIG. 1. DAVY LAMP.

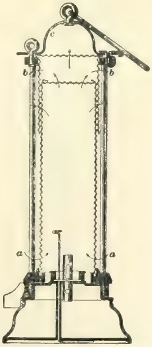


FIG. 2. DAVY LAMP—SECTION.

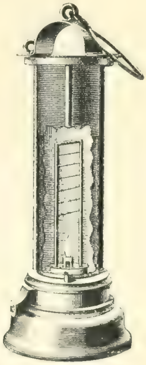


FIG. 3. BEARD-MACKIE LAMP.

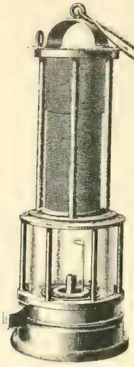


FIG. 4.
CLANNY LAMP.

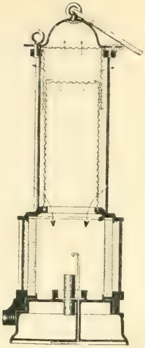


FIG. 5.
CLANNY LAMP—SECTION.

in the year 1811, or early in 1812, he constructed a small lamp of strong glass, the bottom of which was closed with the exception of a small opening to admit air to the enclosed candle, the necessary amount of air for combustion being furnished by bellows. He afterwards, also unsuccessfully, tried a lamp insulated by means of valves, but at last he succeeded in making a perfectly insulated lamp by passing the air from the bellows through a stratum of water below the flame, while the products of combustion escaped through a stratum of water above. Although none of these lamps came into practical use, Dr. Clanny is entitled to the credit for conceiving and first carrying out the idea of constructing an insulated lamp.

Mr. George Stephenson, from the North of England, also invented a safety lamp, and his friends have at various times claimed priority for his invention over that of Sir Humphry Davy. The records seem to show that while Mr. Stephenson undoubtedly invented a safety lamp, this lamp was no more of a practical success than were the several lamps of Dr. Clanny, until after Sir Humphry Davy had made public his discovery of the cooling action of wire gauze, which principle Mr. Stephenson then applied to his lamp. The question of priority of discovery of the cooling action of a gauze or thin plate is still an open one. After Dr. Clanny had tried both the Davy and the Stephenson lamps, he improved the illuminating power of the Davy by surrounding the light with a glass cylinder.

GENERAL PRINCIPLES OF THE SAFETY LAMP.

While the Davy and Clanny lamps of to-day are practically the same as those first produced by Sir Humphry Davy and Dr. Clanny, all other types are combinations and adaptations of the principles of the two, with certain modifications. The general principle involved in the construction of a safety mining lamp is the isolation of the flame from an explosive atmosphere. A flame is a stream of vapour or gas made luminous by heat, usually the heat of its own combustion. As it requires a temperature of 1,220 deg. F. to ignite marsh gas, it is essential that a gaseous atmosphere must be kept from such heat, or, conversely, that such heat must be kept from the gas.

The proximity of any cooling surface whatever to a flame has the effect of reducing the temperature of the burning gases, and the flame is extinguished thereby. This may be shown by presenting a flame to any cold surface, when it will be seen that the flame does not touch the surface. It is separated from it by a thin layer of gas that does not burn, because it has been cooled below the point of ignition. This will continue as long as the surface remains cool.

In the case of a flame impinging against a cool wire gauze, or other perforated surface, the conditions are very favourable for the cooling of the gases of the flame below the point of ignition. As they pass through the small openings, the gases are divided into minute streams or jets by the meshes of the gauze and cooled instantly, being thereby extinguished. It was this fact that Sir Humphry Davy discovered, and which led him to the conclusion that if a lamp flame could be surrounded by an iron gauze it would be prevented from spreading to the surrounding gases. The discovery of this principle at once led to the surrounding of the flame of an ordinary lamp by a metal surface having numerous apertures. Davy made use of the wire gauze for this purpose, while George Stephenson employed a metallic surface punched with numerous small holes. The principle of the isolation of the flame by means of a cold metallic surface, while the light of the lamp was permitted to pass through small apertures, is the same in each of these, but the gauze employed by Davy gave the better light. His experiments showed that a fine wire gauze, composed of wire $\frac{1}{40}$ to $\frac{1}{60}$ inch in diameter, having 784 openings to the square inch, formed by crossing twenty-eight parallel wires, would not permit the flame to pass outside the lamp. By enclosing the flame of an oil lamp within such a gauze, it is surrounded by a safety shield. When the lamp is placed in an explosive mixture, the gas inside the gauze is ignited and burns, but the flame of the burning gases inside the lamp cannot pass through the gauze to ignite the gases outside the lamp, as long as the gauze remains cool.

In the extraction of the coal the miner is exposed to all the dangers incident to a gaseous atmosphere, with which he is continually surrounded. These dangers are twofold in their nature: (*a*) The danger arising from an explosion of mine gas due to its ignition by the flame of a naked lamp or of a blown-out shot, or the sparking of an electric wire or other cause;

(*b*) the danger arising from the poisonous effects of many of these gases, or from suffocation because of their inability to support life. It is the first of these two classes of dangers that we consider in reference to the safety lamp.

REQUISITES FOR A GOOD SAFETY LAMP.

Safety lamps may be divided into two general classes, according to the uses for which they are to be employed :—

(1) Lamps for general use at the working face.

(2) Lamps for testing for gas.

There are some lamps that are designed for general use only, others are designed for the purpose of testing for gas only, while still others are constructed so that they may be employed for both purposes. A lamp, however, that is very sensitive to the presence of mine gas, and thus possesses one of the most important requirements for testing for gas, does not make a good lamp for general use at the face, for the reason that it will require too much watching on the part of the miner in order to avoid the possibility of the flaming of the lamp. On the other hand, a lamp that possesses all the requisites of a good lamp for general use is not adapted to testing for gas.

The following may be stated as the requisites for a good lamp for general use :—

(*a*) Maximum illuminating power.

(*b*) Safety in strong currents.

(*c*) Simplicity of construction.

(*d*) Security of fastening or lock.

(*e*) Minimum liability to flaming and internal explosion.

The requirements of a good lamp for testing for mine gas are :—

(*a*) Sensitiveness to small percentages of gas.

(*b*) A small, uniform, non-luminous flame.

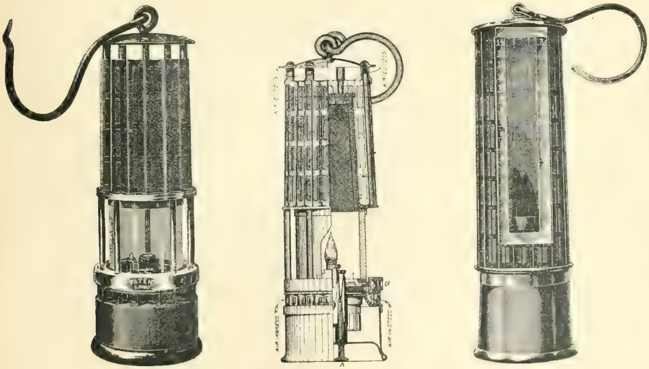
(*c*) Free entry of air into the lamp below the flame.

(*d*) Drawing gas into the lamp from a thin layer at the roof.

TYPES OF CONSTRUCTION.

These several requirements are attained by several different forms or types of construction. The illuminating power of the lamp is increased by as free an entry of air into the lamp as possible. The entry of the air should preferably be at a point below the flame; but when the air enters the lamp above the flame a deflector is often used to separate the ascending and descending air-currents, so as to prevent the smoking of the lamp. The illuminating power is also increased by increasing the draft of the lamp, which is accomplished in the Mueseler lamp by a wrought-iron or copper conical chimney placed within the lamp gauze immediately above the flame. Safety in strong currents is secured by bonnets placed outside of the gauze, or by simple gauze chimneys, as in the Marsaut lamp. Simplicity of construction is important for purposes of thorough and rapid cleaning. There are several forms of lock in use, most common among which are the lead plug lock, and the ordinary turnbolt requiring a simple split key. More recently magnet locks have been introduced, as in the Wolf lamp, that can only be opened by means of a strong magnet. These, perhaps, furnish the greatest security.

The liability to flaming is largely reduced by a good circulation within the lamp. Security against



FIGS. 6, 7, AND 8. WOLF LAMP.

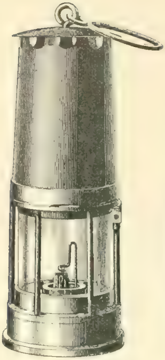


FIG. 9.
MARSAUT LAMP.

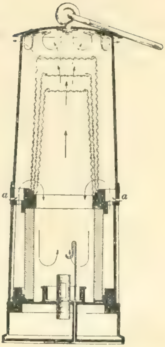


FIG. 10.
MARSAUT LAMP—SECTION.

internal explosions is obtained by means of multiple gauze chimneys and also by metal bonnets. The sensitiveness of the lamp, and its power to detect small percentages of gas in the mine air, which makes it valuable for testing, is secured largely by the free entry of air into the lamp at a point below the flame. This is best attained in the simple Davy lamp, which has always been a favourite with fire bosses.

THE DAVY LAMPS.

The Davy lamp is shown in figs. 1 and 2. The style shown is the lamp used by working miners. There are several different forms of the Davy lamp, but they differ only in size and in the shape of the oil cup. In fig. 2 the arrows marked *a* show the ingress of the air to support combustion, and the egress of the products of combustion is shown by the arrows at the top. There is a double gauze at the top formed by a gauze cap over the main gauze; this is shown by the letter *b*. The gauzes are held in place by the hood *c*, which is hinged and clamped in place by the eyebolt shown just above *b*. The principal use of the gauze cap is to prevent the liability of the gauze being burned through at the top. As shown, the air enters the lamp freely through the gauze, all around the flame, and passes out through the upper part of the cylinder and the gauze cap. This free passage of the air into the lamp at a point below the flame insures a good flame cap for testing purposes. The lamp, however, flames easily, and when unbonneted is not safe in a current whose velocity is greater than 6 ft. per second, as the flame in the lamp is liable to be blown through the gauze. When used by a fire boss for testing purposes, the flame is turned low by use of the hooked wire picker shown in the sectional view. The lamp is then carefully lifted toward the roof of the mine. If there is gas present in small quantity a cap or halo shows on top of the flame. If in larger quantities, the gas burns with a blue flame inside of the gauze. When the presence of gas is thus shown, the fire boss carefully and slowly lowers the lamp, until it is either below the stratum of gas, and retreats with the lamp held near the floor; or he puts it under his coat and extinguishes the flame inside the gauze by smothering it, and retreats in the dark.

The most recent improvement in the Davy lamp for testing purposes is the Beard-Mackie safety-lamp attachment. It is the joint invention of Prof. J. T. Beard, Principal of the School of Coal Mining of the International Correspondence Schools, and Matthew D. Mackie, an experienced fire boss in the employ of the Delaware, Lackawanna and Western Company. It is a sight detector of simple design and can be used in almost any testing lamp. It consists of an iron or brass rod so bent that it forms two parallel legs of any required length, and from ¾ in. to 1 in. apart. The two ends of the rod are soldered to a brass ring which fits down over the burner of the lamp, and which is held in place by any kind of a set-screw or clamp, and the two legs extend perpendicularly into the lamp to the desired height. Strands of fine platinum wire, at regular distances, are stretched horizontally from one leg to the other. This makes a miniature ladder with brass or iron sides and platinum wire rounds. The lower strand is arranged at such a height as to be just at the point of incandescence when the lamp is in pure air. The successive strands above this are arranged at such heights as will indicate the percentage of gas, if that is desired, or less accurately for practical testing purposes, to show danger points. The practical value of the device lies in the latter feature, and the fact that it readily shows the relative explosiveness of the mine air, and the fluctuation in the amount of gas present.

This device is shown in fig. 3.

In testing for gas, a reduced flame in the lamp is used, and the heights of the wires must in such cases be adjusted accordingly, and they will be equally as effective as when a normal flame is used.

On account of the sensitiveness of the platinum wire, due to its absorption of the gas, it becomes incandescent at a much greater height than is reached by the flame. In the use of a flame ¾ of an inch in height, the strands will glow brightly to a height of 1¼ in. above the tip of the luminous flame when two per cent. of gas is present.

This appliance has been unanimously endorsed by the Association of Fire Bosses of the D., L. and W. mines. I recently saw a demonstration of its action when used in a Davy lamp in a gaseous atmosphere, and I was particularly attracted by the positive, sharp manner in which the incandescing of the successive wires indicated the increasing percentages of gas, and also with the fact that the lower wires were brightly incandesced by so small a percentage of gas as would hardly show a perceptible cap on the flame.

FORMS OF THE CLANNY LAMP.

There are as many, if not more, forms of the Clanny lamp than of the Davy. All of them are, as in the case of the Davy, simple modifications of the original lamp. The characteristic feature of the Clanny lamp consists in the substitution of a strong glass cylinder for the lower part of the gauze cylinder of the Davy lamp. In other respects it is the same as the Davy lamp. The entry of the air in the Clanny lamp, however, takes place above the glass cylinder (figs. 4 and 5), the entering air descending inside of the lamp to the flame. This gives rise to conflicting descending and ascending air-currents within the lamp, which often produce a smoky flame. This feature of the Clanny lamp impairs its illuminating power, as the glass cylinder becomes smoked and the flame itself is not as bright, owing to insufficient draft. The lamp does not present the conditions favourable for testing for gas, the lamp flaming readily in a body of fire-damp, and the flame not being sensitive to small percentages of gas. This lamp is also made in brass and aluminum, and with various forms of lock fastenings and oil vessels.

The unbonneted Clanny lamp is not safe in a current of air having a greater velocity than 8 ft. per second. One improvement which tends in a slight degree to obviate this fault, is a small iron or copper shield, about 1 in. in width, surrounding the lower part of the gauze immediately above the glass cylinder. While this is a slight improvement, it is not as effective as the bonnet, which completely covers the gauze cylinder, except that means are left for the egress of the products of combustion near or at the top.

THE WOLF LAMP.

The Wolf lamp is one which has met with practically unanimous approval from mine managers both in this country and in Europe. It is the invention of Mr. C. Wolf, of the firm of Friemann and Wolf, of Zwickau, in Saxony. This lamp is shown in figs. 6, 7 and 8. It was evolved from the Clanny lamp.

The chief characteristics of this lamp are: (1) The adaptation of the oil cylinder for burning naphtha, thereby greatly increasing the illuminating power and the sensitiveness of the flame; (2) the introduction of an ingenious igniting arrangement, which permits the miner to relight the lamp without danger in case the flame is either accidentally extinguished or has been extinguished by gas burning inside the gauze; (3) a magnet lock or fastening which prevents any tampering with the lamp by the miner. The lock can only be opened by the use of a very strong and heavy magnet at the surface or lamp station.

At first the idea of the use of so volatile an illuminant as naphtha prejudiced many mining men against this lamp; but the method of using the naphtha, and the use of an automatic lamp filler overcomes all the objections. The naphtha in the oil chamber is held in an absorbent material, and the flame is fed from the volatile gas arising therefrom. The flame is a particularly bright one, and has about double the candle-power of the best safety lamps of other types. The cost of the naphtha is about one-quarter that of the oil used in other lamps. The Wolf lamp is essentially a working lamp, and is not intended for testing purposes. It will show the presence of gas in the air when the percentage is as low as one per cent., but it will invariably go out before the mixture of gas and air reaches the explosive point.

The manner in which the lamp takes its air is shown in fig. 7. It enters in a tortuous way through port-holes below the flame, passing through a gauze ring before it enters the lamp, and the products of combustion find egress from the top of the double conical gauze chimneys, as shown by the arrows. The gauze chimneys are protected by a bonnet, which completely surrounds and extends above them. This bonnet is fluted and contains a number of port-holes, which are so arranged that an air current blowing against the lamp cannot find direct ingress. The thumb-screw, by means of which the igniter is operated, is shown at *A*, and the magnetic lock at *B*. This lamp has been proved capable of withstanding an air current with a velocity of more than 59 ft. per second. Its value as a safe lamp is attested by mine officials and mine inspectors, and it is so highly esteemed that the Bituminous Mine Law of Pennsylvania, which formerly strictly prohibited the taking of volatile oil into a bituminous mine in Pennsylvania, was, at the request of mine officials and mine inspectors, amended in 1901 to read: "No volatile oil, *excep*

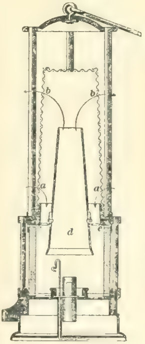


FIG. 11.
MUESELER LAMP.

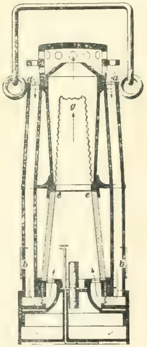


FIG. 12.
ASHWORTH-HEPPLEWHITE-GRAY LAMP.

than used in approved safety lamps, shall be taken into any mine," etc.

These lamps are made of various metals, including aluminum alloy, the latter material making an exceedingly light-weight lamp.

THE WOLF-STUCHLIK LAMP.

Messrs. Friemann and Wolf have just placed on the European market a new lamp known as the Wolf-Stuchlik lamp. This lamp retains the general form of the Wolf lamp shown, but the oil chamber, instead of being constructed for the use of naphtha, is constructed as an acetylene lamp. This lamp will give a light equivalent to 7 candle-power, as against $\frac{6}{10}$ candle-power of the best oil-burning safety lamps, and the 1 candle-power of the Wolf naphtha lamp. There is a horizontal reflector affixed to this lamp, which, when so desired, reflects the light against the roof; the upper frame of the lamp and the handle by which it is carried being so arranged as not to interfere with the rays of light. That it gives increased light without increased danger, and that by its use the mine roof can be inspected, are features of great value.

THE MARSAUT LAMP.

The Marsaut lamp is similar to the bonneted Clanny lamp in every respect, but is supplied with three gauze chimneys as shown in figs. 9 and 10. It is a peculiarly strong lamp in this respect, as the security against explosions of gas within the lamp is thereby increased. This lamp is often extinguished in an explosive mixture by the force of the explosion within itself. It gives a good light and is a good lamp for the working miner. The Marsaut lamp has been improved by the addition of a deflector known as Howat's deflector. This consists of an annular ring placed about 1 in. above the top of the glass cylinder, and so as to fill the annular space between the bonnet and the gauze. Resting on top of the cylinder, and extending almost up to this annular ring, is a metal diaphragm which serves to deflect the entering air down upon the flame. This greatly increases the illuminating power of the lamp.

THE MUESELER LAMP.

In the Mueseler lamp (fig. 11), the attempt was first made to increase the draft, and thereby improve the illuminating power and prevent smoking. The lamp is provided with a central conical tube or chimney, *d*, of sheet iron, held in position by a horizontal perforated diaphragm of sheet iron, *e e*, at the junction of the gauze and glass cylinders. Air enters the lamp through the gauze, *a a*, and, passing through the perforations of the diaphragm, *e e*, is drawn down under the expanded mouth of the central chimney in close proximity to the flame, and passes out of the chimney and through the gauze, *b b*. The draft of the chimney materially increases the illuminating power of the lamp, while the central tube adds very largely also to the security of the lamp against currents and inner explosions, the latter seldom being communicated outside of the lamp. It is not a lamp adapted to the detection of gas, but it is reported to have safely withstood a current of 100 ft. per second. It does not flame as quickly as the Clanny lamp. This lamp is made with or without a bonnet.

THE ASHWORTH LAMP.

The Ashworth lamp has the flame surrounded by a conical glass chimney, which at the top fits into a brass cap surmounted by a single gauze about 1½ in. in height, also conical in shape. This gauze is surrounded by a brass cylinder which is conical at the top and open. The entire upper part is encased by a brass shield perforated on the sides and top. The air and mine gases enter through these perforations, pass down through the standards connecting the brass shield and the lower part of the lamp, then through a narrow gauze about ½ in. high, placed directly beneath the glass chimney, and into the flame of the lamp. The hollow standards also have openings at the bottom, which are ordinarily kept closed by a slide, but the slides may be raised and the air thus taken from a point near the base of the lamp.

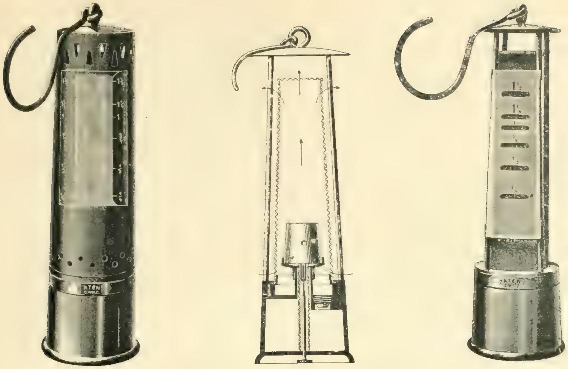
THE GRAY LAMP.

The Gray lamp is a Clanny lamp with the wire gauze of the upper half of a Clanny replaced by a solid metal chimney, which opens into a low cylindrical space surrounded by a wire gauze. The top of the lamp is perforated and protected by a horizontal wire gauze. All of the air enters from the extreme topmost point of the lamp, and is then led through four hollow standards connecting this top chamber with the base of the lamp into the combustion chamber below the flame.

THE ASHWORTH-HEPPLEWHITE-GRAY LAMP.

The Ashworth-Hepplewhite-Gray lamp, shown in fig. 12, is an improved combination of the Ashworth and Gray lamps. It is one of the best and most convenient of the lamps for testing for gas. When the lamp is being used for testing, the air enters the tops of the four standards, *a a*, and passing down through the standards, enters the lamp below the flame, thereby producing the best conditions for yielding a good gas cap. The glass chimney, *e e*, tapers toward the top, and the same conical shape is also given to the gauze chimney, *g*, which is bonneted as shown. The conical shape of the glass assists the upward diffusion of the light, and makes the inspection of the roof easier, while the same shape in the gauze chimney renders the lamp more safe and secure against an inner explosion of gas being communicated outside of the lamp. The air being drawn into the lamp through the top of the standards makes it possible with this lamp to detect a thin stratum of gas near the roof. When not in use for testing, the air may be admitted at the bottom of the standards, at *b b*, by moving a little shutter that closes them.

The wick of this lamp, when at a normal height, furnishes a flame of great illuminating power. When



FIGS. 13, 14, AND 15. PIELER LAMP.

lowered by a fine screw adjustment, the flame becomes blue and non-luminous, and does not interfere, therefore, with the easy observation of a pale cap.

THE PIELER LAMP.

The Pieler lamp, shown in figs. 13, 14 and 15, has a gauze similar to a Davy lamp, but burns alcohol instead of oil. In its form, the gauze is bonneted by a sheet-iron bonnet, the gas caps being observed through a glass window. This window is very apt to become dimmed with smoke and moisture, thus impairing the observance of the caps. A shield, *c*, surrounds the flame, which is adjusted so that its tip does not extend above the top of the shield.

This lamp was designed by the inventor to yield a standard flame which would always present a certain height and volume, and yield flame caps of a uniform height for given percentages of gas. The following table was prepared by him to show the percentage of gas corresponding to different heights of flame caps, measured from the top of the shield, *c* :—

¼ per cent. of gas yields a cap 1·25 in. high.
½ per cent. of gas yields a cap 2·00 in. high.
1 per cent. of gas yields a cap 3·50 in. high.
1½ per cent. of gas yields a cap 4·75 in. high.
1¾ per cent. of gas cap reaches the top of the lamp, and beyond this percentage of gas the lamp fills with flame.

The lamp flames easily in a mixture containing more than 1¾ per cent. of gas, and is, therefore, dangerous, requiring great care and caution in its use. Any variation in the strength of the alcohol varies the height of the flame, which is, therefore, not strictly a standard flame.

THE DICK LAMP.

The Dick lamp is another of the various forms of the Clanny lamp which have been introduced. The features of this lamp are the insertion of a rim of brass or zinc in the upper portion of the steel bonnet, for the purpose, it is claimed, of reducing the conductive power of the bonnet and cooling the lamp. Another essential feature of this lamp consists in the tangential position of the port-holes by which air enters the lamp through the bonnet. There are several rows of these port-holes extending around the bonnet and also the brass ring mentioned above. There is also a circular air box immediately above the glass cylinder, which is constructed to admit the air into the lamp through a separate gauze. This air supplies the flame of the lamp, while the air entering through the tangential port-holes in the bonnet serves the purpose of cooling the gauze chimney. It has never come into general use. The Derbyshire Clanny lamp differs from the ordinary bonneted Clanny, only in having a small inner bonnet at the top of the lamp for the more thorough protection of the openings at the top of the outer bonnet. The Garforth lamp is another type of the bonneted Clanny, from which it differs in no essential particular.

THE MAUCHLINE LAMP.

The Mauchline lamp is a simple unbonneted Clanny in which the glass cylinder is replaced by a strong convex lens in one side of the lamp, while a reflector is placed in the opposite side. Between these, upon either side of the lamp, are small circular openings for the entrance of air, protected by gauze. It was designed for use in making mine surveys, but has only been used to a limited extent.

There are numerous modifications of the Clanny and Davy lamps, designed for the use of fire-bosses, besides those already mentioned and described. As they have not won even partial approval from mine officials, the writer does not think it well to enter into descriptions of them. In the collection of lamps they are simply curiosities.

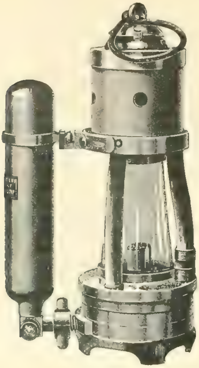


FIG. 16. CLOWES LAMP.

THE MARSHALL LAMP.

The Marshall lamp has a conical bonnet, inside of which is a single gauze, this gauze being surrounded at the bottom by a second gauze and being connected at the bottom and on the inside to a metal deflector. The glass part of the lamp is entirely similar to the Clanny. Surrounding the glass chimney are five upright standards, one of which is movable up and down; by moving it downward, the upper part of the lamp can be locked to the oil chamber, and then by means of a hasp and staple the parts of the lamp are still further locked.

THE CLIFFORD LAMP.

The Clifford lamp has a double bonnet, which is perforated to admit air. The lower part of the lamp very closely resembles the ordinary Clanny; but above the flame, and in place of the inclined metal chimney of the Mueseler lamp, is a bell-shaped glass chimney, like the lower part of an Argand chimney. This fits into a metal tube, about which, at its connection with the Argand chimney, is a double gauze, which completely insulates the flame chamber. This metal chimney opens at the top into a cylindrical chamber, which has a small opening at its top and across which is a gauze.

THE COSSET LAMP.

The Cosset lamp is a form of the Mueseler lamp, manufactured in France. In the ring, in which the lower ends of the standards rest, is a series of depressions or notches. A pin projects from the upper rim of the oil cup, and this pin is forced upward by a spring, but it can be withdrawn by turning a screw at the bottom of the oil vessel. This same screw also lowers the wick, so that when the pin is being withdrawn the wick is also being screwed down so low that the light will be extinguished. Desiring to use the lamp, the wick and pin are raised by turning the screw at the bottom of the oil vessel. The wick is lighted and the oil cup is then screwed into the top part of the lamp. It cannot be unscrewed as long as it is burning, because the projecting pin in the oil vessel catches in the depressions previously mentioned, which act like a ratchet, and to withdraw this pin also withdraws the wick and extinguishes the light.

The New Type Cosset lamp is a two-gauze Marsaut lamp of French manufacture. The upper rim of the oil vessel has teeth which form a rack. The glass cylinder of the lamp is surrounded by six standards. One of these standards is hollow and can be detached from the lamp. At either end of the detachable standard are projecting pins forced outward by springs within. One of these projections, when the standard is upon the lamp, passes down through the lower ring surrounding the glass and rests upon the rim of the oil cup. The upper projection contains a small hole, and this hole extends above the upper rim, which holds the standards. When the lamp is to be used the movable standard is placed in position, the wick ignited, and the oil cup screwed into the body of the lamp. A lead plug is then placed through the hole in the upper projection of the movable standard. In this condition the lamp cannot be opened, because the lead plug in the upper end prevents that projection from being depressed, so the standard can be entirely removed, and until that is done the lower projection catches upon the teeth of the rack on the oil vessel and prevents the latter from being turned.

THE CAMBESSEDES LAMP.

The Cambessedes lamp is also a French lamp, having a broad circular base, hollow standards like the Ashworth-Hepplewhite lamp and an Argand burner

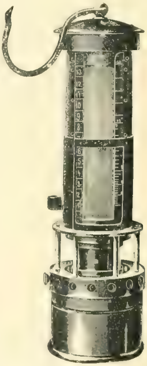


FIG. 17.
CHESNEAU TESTING LAMP

like the Pieler. An extra oil reservoir extends half way around the glass cylinder. This oil vessel is made of a light-coloured metal, and the side turned toward the flame is polished so as to act as a reflector. A circular disk of gauze fits over the top of the hollow standards, and is held in place by a circular plate, through the centre of which a conical chimney is passed to within an inch or so of the wick. This chimney is surrounded by the usual cylinder of gauze, which extends to the top of the lamp. The air is always admitted through the circular disc of gauze at the top of the standards, passing down through them and up into the flame. The wick is raised and lowered by turning a thumb-screw at the side of the oil vessel. A wire passes through the bottom of the oil vessel to the wick, to remove from the latter all charred particles that adhere to it. This wire is held in its highest position by means of a hooked piece of metal soldered to the bottom of the oil vessel, under which the bent end of the wire is slipped. This prevents it from sliding down and becoming bent when the lamp is set down, a difficulty experienced with the wire "pickers" for raising and lowering the wicks, which are common in so many kinds of lamps.

OILS.

All the lamps described above, with the exception of the Ashworth-Hepplewhite-Gray, the Pieler, and the Wolf lamps, are constructed to burn either vegetable or seal oils. Light mineral oils are burned in the three exceptions.

According to the English Mine Commission, the safest oils to use are vegetable oils, such as rape. (made from rape seed) and colza (made from cabbage seed) and seal oil. None of these are explosive. Petroleum used alone is liable to explode, and should be avoided.

In point of brilliancy, the flame of a lamp burning seal oil is superior to one burning either rape or colza oil, and the wick is less liable to become charred.

By addition of one part of petroleum to two parts of rape-seed oil the light is increased.

Many of the oils in common use in safety lamps have a tendency to incrust the wick and thereby lower the flame. Petroleum or benzine added to the oil reduces this tendency and yields a better flame for testing purposes. Alcohol yields a hotter and less luminous flame and a much higher cap. In some cases, a hydrogen flame has been used for testing purposes. The hydrogen is compressed into a small steel cylinder attached to the lamp, and is burned in the lamp at the mouth of a small tube. This apparatus gives a standard flame for testing, but it cannot always be conveniently obtained.

Figs. 16 and 17 show respectively the Clowes lamp and the Chesneau testing lamp.

Read before the Franklin Institute.

THE GALVESTON SEA WALL.

THE November issue of the *American Review of Reviews* has a short but interesting account of the great sea-wall which is being built to protect the city of Galveston, Texas. In September 1900, a disastrous storm swept over the island causing heavy loss of life and property. The citizens faced the situation with remarkable grit and enterprise, declining to change the locality of Galveston, and determining to defend the city instead with a sea-wall nearly 18,000 feet in length. This skirts the shore of the island in front of the most exposed portion of the city. Its top is three feet above the highest point reached by the water in the storm of 1900. Here the wall is five feet in width, gradually extending to sixteen feet on the bottom. It is concaved on the side exposed to the Gulf, in order to minimise the force of the waves; but an additional barrier is provided in what is called "rip-rap" work, composed of blocks of granite laid along the water face of the wall. This formation is twenty-seven feet in width, and the stone is piled to a height ranging from three to five feet above the surface of the water. When it is stated that some of the single blocks weigh a ton apiece, an idea of the massiveness of this protection can be gained, while special care has been taken to prevent the wall from being undermined, since the island is composed so largely of sand.

Before it was laid a foundation was made by driving wooden piles through the sand into the clay formation which exists below it. To the piling was fastened a face of heavy planks, also driven down to the clay. A trench three feet deep was excavated back of the planking, which was filled with concrete, and upon this blocks of the same material laid to form the wall proper, the material being manufactured by special machinery on the spot and moulded into the proper size and shape.

To further strengthen the wall, the shore back of it is being filled in with earth and stone to a depth of two hundred feet and those in charge of the improvement have taken advantage of this to form an ornamental feature which will be one of the greatest attractions of the city.

THE MANUFACTURE AND USE OF CONCRETE.

BY

A. LEGG, M.Inst.C.E.

The present article is largely devoted to Portland cement. The author discusses tests for fineness of grinding, specific gravity, strength, hydraulicity, speed of setting, and soundness. In the following article, consideration will be given to good hydraulic limes, such as may be produced locally.—Ed.

I.

At first sight the making of concrete appears to be one of the simplest operations which the engineer can be called upon to undertake, simply the throwing together into a compact mass of fragments of rock or other material and binding them together by some cementing substance. But experience shows that it is an operation the perfect conditions of which are not always understood, and still less often put into practice, and it is safe to assert that a large proportion of the concrete made is very far from what it ought to be.

I shall for convenience throughout this paper, refer to the cement and sand, or other cementing mortar as the *matrix*, and the broken rock, gravel or other similar material used as the *aggregates*.

EARLY USERS OF CEMENT.

The use of concrete as a building material is a very ancient practice, and many structures of great age standing in various parts of the Old World testify to the skill of the ancient builders in its use. In Britain are many ruined Roman fortresses which, but for the excessive zeal of Oliver Cromwell, might still have been standing in almost as good condition as on the day when the workmen left them. The cement used in these early times, and, indeed, until the early part of the nineteenth century was lime—sometimes a weak fat lime, but oftener a more or less hydraulic lime. The conditions governing its hydraulicity were probably little understood, but observation and experience had shown that certain limestones produced lime having hydraulic properties, superior to that produced from other stones, and they had gradually come to be marked and used by preference where hydraulic properties were required.

PORTLAND CEMENT.

It was not, however, until the early part of the nineteenth century that any systematic investigation was made regarding the conditions producing hydraulicity in lime, which investigations culminated about 1830 in the invention of Portland Cement.

About that time was beginning an era of great activity in civil engineering. The construction of canals and roads throughout Britain and other European countries, the invention of the steam engine, and the subsequent development of railway construction, and later the systematic construction of water and drainage works, have all contributed to the increased demand for a good hydraulic cement.

It is only within the last thirty years or so, however, that Portland Cement has begun to be used to any great extent, and during that period the uses to which it has been put by the engineer have been ever increasing. Beginning with its cautious adoption for the backing up of brickwork or masonry facings, increasing knowledge and experience of its properties have led the engineer to the constantly increasing use of this material until now he does not hesitate to use it, when properly prepared, as a fit and proper substance, not only for backing but also for the facing of his structures, deeming it capable of resisting the action of the elements even in the most exposed situations.

THE CHEMISTRY OF CEMENT.

I do not propose to occupy too much space by going into the chemistry of the subject, but it may be useful to point out briefly, the difference between pure lime, commonly called *fat lime*, and hydraulic limes and cements.

Ordinary lime is produced by burning or roasting marble chalk, or some other pure form of limestone. During the "burning," carbonic acid is driven off, and more or less pure lime, "calcium monoxide," remains. This combines very readily with water, falling to a white powder called "slaked lime," which, when mixed with sand, forms the ordinary lime mortar used in building construction. Such mortar sets simply by *drying*—a purely mechanical process—never attains any great degree of strength, and is not able to withstand the continued action of water.

It is true that a certain chemical action afterwards takes place, due to the absorption of carbonic acid from the atmosphere, whereby a harder skin of carbonate of lime is formed, which resists the action of water; but this is merely superficial, penetrating into the substance of the mortar with extreme slowness. When air is excluded this action does not take place, hence the unsuitability of fat lime concrete for work underground or underwater.

HYDRAULIC LIMES.

Hydraulic limes are produced by a similar process of burning less pure forms of limestone containing besides the calicum also silica and alumina. The resulting lime, when slaked with water, gives a compound silicate of lime and alumina, which sets, not mechanically like the fat lime, but by crystallisation, forming a substance unacted upon by water. Such lime is usually ground finely before being slaked by water.

Now Portland cement is a hydraulic lime in which the proportions of calcium, silica and alumina, instead of being accepted as they are found to be thrown together by nature in certain limestone rocks, are accurately determined by the chemist in the degree best suited for the production of the particular properties which the engineer demands, and so make it possible to produce always an exact uniformity of composition.

TESTING REQUIREMENTS.

It is not intended to enter into a discussion of the proportions of the various ingredients necessary to produce the best results, nor of the best chemical composition for the resulting cement. I am well aware that many engineers, in order to obtain the quality of Portland cement which they require, are in the habit of specifying that a chemical analysis of the cement shall reveal a particular composition. This I do not consider desirable. Unless he is an expert chemist, not only in a general sense, but also particularly with regard to the manufacture of Portland cement, the engineer will do well to leave the chemical composition to the manufacturer. He may, however, with advantage, demand to be supplied with an analysis of the cement by some chemist of repute, which will have a beneficial effect in inducing the manufacturer to send out such a cement as will be approved by the chemist expert, and such analysis will also be useful to the engineer for future reference and comparison.

He may also, if he feels sufficient confidence in his knowledge of the subject, demand that certain of the constituents, as the lime, silica and alumina, shall not exceed certain percentages. Excess of lime being liable to cause blowing after setting, and excess of silica and alumina to give weak cement. Further than this, I consider the engineer should not go. The properties of the cement which the engineer may, and which it is his duty to insist upon in order to obtain uniformly sound cement, are such as he is able himself to test by simple mechanical means. These properties he is to insure by imposing and strictly adhering to certain mechanical tests. Chief amongst them are the following :—

(1) Fineness of grinding ; (2) weight or specific gravity ; (3) strength ; (4) hydraulicity ; (5) speed of setting ; (6) soundness.

FINENESS OF GRINDING.

This is of the utmost importance. It affects the weight, the speed of setting, and last but not least the economic value of the cement.

I can well remember when a cement about 90 per cent. of which passed a sieve of 2,400 meshes to the square inch, was considered a finely ground cement, and when even 90 per cent. passing a 1,600 mesh was not an uncommon specification for fineness. Now the same percentage applied to a 5,625 mesh is an ordinary requirement, and I am convinced that before long we shall require that at least 90 per cent. shal pass a sieve of 10,000 meshes to the inch.

Coarse grains in a cement are at the time when it is used equivalent to so much sand as they have little or no cementitious value. Later on they may possibly have an actually pernicious action, for it is extremely likely that these grains, having resisted the action of the water for a time may, after the surrounding cement has already set, continue to be slowly acted upon, undergoing a slaking process, which may be accompanied by sufficient expansion to materially weaken or even rupture the work.

No definite degree of coarseness appears yet to have been determined beyond which the grains cease to be of value as cement, but certainly grains which will not pass a sieve of 2,500 meshes to the square inch are worthless, and should be rejected.

SPECIFIC GRAVITY.

The weight per cubic foot is usually looked upon as being a test of the thoroughness of burning. Certainly the weight of the *clinker* increases with the degree of burning, but as the weight of the cement varies also with the degree of fineness of the grinding, this latter factor must always be taken into account in judging the weight. It would be absurd to specify a very high weight with very fine grinding. For a cement 90 per cent. of which passes a 5,625 mesh of 112 lb. per striked bushel is the highest weight that should be imposed.

The specific gravity would, however, at all times be a more reliable test than the weight. 3·1 to 3·15 may be taken as the specific gravity of a good sample of cement.

STRENGTH.

The strength test most usually adopted is that for neat cement. A fair test for a seven days' old briquette is 400 lb. per square inch. It is possible to obtain much higher results than this, and 700 lb. to 800 lb. per square inch are within the author's experience. Such high results, however, at seven days are not always indicative of a really strong and sound cement, and it is much more important that there should be a good regular increase of strength with age than to have a very high seven days' test.

A briquette giving 400 lb. per square inch at seven days ought reasonably to be expected to show the following increases :—

At 7 days.. .. 400 lb. per square inch.
At 28 days.. .. 550 lb. per square inch.

Although the neat cement test has a certain value to the engineer for comparison and reference, it is not nearly so reliable an indication of the quality of the cement for ordinary use as a sand test. Indeed, it is quite possible for a very finely ground cement to give a higher neat tensile test when adulterated with a small percentage of coarse sand, or other strong inert substance than when pure and unadulterated, and a knowledge of this fact may be taken advantage of by an unscrupulous manufacturer, if only the neat cement test be imposed. Such adulterations would, however, be detected in the sand test, as the adulterant would then go to increase the ratio of sand to cement, and would weaken the briquette.

The mortar test is, therefore, altogether the more reliable, and should always be insisted upon in order to obtain a good and uniform cement. The apparent anomaly of the adulterated cement giving a higher tensile test than the unadulterated is probably due to the fact that the very fine grinding increases the *adhesive* power of the cement, whilst decreasing the *cohesive*, and that, therefore, the higher cohesive power of the larger grains to which fine cement strongly *adheres*, tends to give a higher average strength of briquette.

The following may be taken as fair tests to be imposed for briquettes compound of one part cement to two of sand :—

At 7 days old	..	150 lb. per square inch.
At 28 days old	..	200 lb. per square inch.

SPEED OF SETTING.

The time of setting is chiefly dependent on the fineness of grinding, and the age of the cement, and is a test which indicates rather the readiness of the cement for use than its quality of manufacture, and therefore one to be made *on the works*, before any cement is allowed to be used. Any cement showing very quick setting should be allowed to lie for aeration until the test shows the setting time to have become sufficiently prolonged. Initial set in less than twenty minutes would be a fair limit, under which to include quick setting cements.

SOUNDNESS.

The usual test for soundness is to make pats of heat cement 3 in. or 4 in. diameter, about ½ in. thick, and thinned to the edges. These are to be kept under water for twenty-eight days, during which any cracks developing will indicate unsoundness. Such cracks, when they appear, usually do so on the thin edges. A good test for expansion during setting is to fill ordinary cylindrical lamp glasses with the gauged cement, when any expansion will show by the cracking of the glass during the setting.

HYDRAULICITY.

The hydraulicity of the cement is shown generally indirectly in making the tensile tests and those for soundness as the briquettes and pats are kept under water until tested.

The demands of the engineer for a better and more reliable cement, demands based upon a certain knowledge of what is required, chiefly obtained by means of a continuous and systematic application of the mechanical tests enumerated, have, during the past thirty years, been fruitful in the production of a cement of ever-improving quality, and have established certain standards which, within narrow limits, enable him to specify and to obtain with great exactness the material most suited for a particular work which he may have in hand.

Portland cement has thus been dealt with at some length, because it is by far the most generally useful cement at the disposal of the engineer, but where the cost of Portland cement becomes very high on account of great cost of transport, as is the case in many parts of this country, it is quite possible that good hydraulic limes may be produced locally which will, even when the dimensions of the work have been increased where necessary to give equal strength, show an advantage in their favour over the use of Portland cement.

The sand to be used with the cement to form the matrix really acts as a diluent to reduce the quantity of cement otherwise necessary. It should be clean, as sharp as possible, and of a fineness suited to the purpose for which the concrete is required, *e.g.*, water-tight concrete would require a finer sand with the same quantity of cement than might be necessary for concrete required simply for weight bearing.

No sand gives better results for either purpose than that produced by pulverising a good gritty sandstone rock, and although this may be too costly to enter into competition with natural sand, cases frequently occur where it is the only practicable source.

We now pass to the consideration of the materials which are to be used in conjunction with the cement to form the concrete, and which we have called the aggregates, and here we at once find ourselves in a much freer atmosphere. We have seen that the number of cements useful from the point of view of the constructional civil engineer is very limited, so much so, that we have dealt at length with only one class, viz., that of hydraulic limes. And, indeed, one may say, with only one variety of that class, viz., Portland cement. When, however, we come to deal with the aggregates, we find that the number and variety of materials is so great as to render a complete enumeration almost impossible. We shall, therefore, in the first place, state some general conditions and qualifications necessary, and give a few typical examples of materials fulfilling these conditions.

(*To be continued.*)

Read before the Cape Society of Civil Engineers.

NEW OPENINGS FOR MACHINERY AND ENGINEERING IN SOUTH AFRICA.

The Blue Book from which the following facts are taken is of very exceptional importance, and contains much information valuable to engineers on "the present position and future prospects of British Trade in South Africa."—ED.

THE latest Blue Book on South Africa is the outcome of a commercial mission, and embodies the conclusions of Mr. Henry Birchenough, the special Commissioner appointed by the Board of Trade. Repeated reference is made to competition in machinery and engineering work, and it is a fact patent to everyone, says Mr. Birchenough, that *there* lies the great battlefield of competition in South Africa.

It is encouraging to note that, according to this report, there is undoubtedly among all classes in South Africa a strong and patriotic desire, in view of the sacrifices of the late war, to keep as large a proportion as possible of the trade of the Colonies in British hands. The Commissioner reports, moreover, that the present moment is peculiarly favourable for the extension of British trade, and for the establishment of a sound and practical system of commercial intelligence between Great Britain and the South African Colonies.

The most illuminating feature of the report is that which refers to new openings for trade, this subject being treated very fully by the Commissioner.

MAIN CHANNELS FOR INCREASED BUSINESS.

The following summary will give an indication of the main channels increased imports may be expected to follow :—

(1) The development of the various mining industries—gold, coal, iron, and diamonds—involving a large capital outlay for equipment, and a greatly increased consumption of imported stores.

(2) Railway extension in the different Colonies, with an immediate demand for material and rolling stock.

(3) Government expenditure upon docks and harbours, public buildings, irrigation works, etc.

(4) Necessary and pressing municipal outlay upon sanitation, water supply, public buildings, electric lighting and traction, etc.

(5) Private enterprise of all kinds, both in the extension of old and the creation of new industries, building operations, etc.

(6) The prosecution of agricultural operations upon more modern and scientific principles than have been practised hitherto.

(7) The concomitant increase in the demand for general merchandise of all kinds, to satisfy the demands of a larger and more prosperous population—white and black.

Each of these headings is dealt with in some detail.

NEEDS OF THE MINES.

The gold mines afford an enormous field for trade expansion, both as to capital outlay on plant and machinery and for ordinary mining stores. Existing companies estimate that, given an adequate supply of labour, they will be able to invest about £50,000,000 upon fresh development during the next ten years, about one-third to half of which would be expended upon imported plant and machinery. Deep level mining involves very heavy outlay in equipment.

There are at present about 6,500 stamps upon these fields, all of which will probably be at work again in the course of the next twelve months. Leaving the realm of conjecture and prediction, it may be asserted that for every additional new stamp that is erected £1,600 worth of imported machinery will be required, and this includes mining machinery of all kinds winding and mill engines, boilers, stamp batteries, air compressors, rock drills, pumps, steel cyanide tanks, conveyors and sorting belts, trucks and rails, steel headgears, electrical equipment and machinery of all kinds.

But apart from new development, considerable expenditure will have to be incurred in order to keep the equipment of the existing mines up to date, in the following directions :—

Labour saving appliances of all kinds such as belt conveyors for handling rock, sands, slimes, and refuse, sorting belts, mechanical stokers, all forms of mechanical underground traction.

The substitution of central electrical power stations upon each mine or group of mines, in place of the present scattered plant, will largely increase the demand for electrical machinery, such as generators, motors, electrically-driven pumps, etc. The use of electrical power, especially in the deep level mines, where it possesses many advantages over compressed air, is quite certain to take an enormous extension during the next few years, and deserves the closest attention on the part of British manufacturers. It is the general opinion of engineers upon the Rand that the future belongs to the three-phase alternating system, because of its greater flexibility, and not to the continuous current system.

Steel head-gears are rapidly taking the place of timber head-gears. There is also an inclination to substitute steel for timber, which is expensive and requires frequent renewal, in mine shafts, and to adopt the system of steel frame buildings, where practicable, upon the mines. This is a branch of trade which has a very great future in South Africa. The mines afford a particularly promising opening for steel construction in all its branches. There is already considerable competition on the part of both Americans and Germans, but so far as could be gathered, the feeling is decidedly in favour of British work. As this branch of trade is really only in its infancy on the Rand, and is capable of great expansion, it is recommended very strongly to the attention of British firms.

Other items which may be mentioned as likely to afford new or extended openings for trade are—Improved diamond drills for deep boring, oil and gas engines, water purifiers, steam trollies, steam lorries and traction engines, lighter but equally strong steel ropes for deep level mines, all labour-saving inventions, especially in connection with underground traction and the working of drills.

In addition to the capital expenditure on the mines, a considerable extension of trade may be expected from the increased consumption of mining stores. In the case of Johannesburg these are almost all bought locally.

It is absolutely necessary that manufacturers who wish to obtain a share of the trade should be directly represented in Johannesburg, otherwise they will not be in a position to compete. It is also important that they should hold stocks, either upon the spot or at the coast, from which they can execute orders promptly.

Almost everything which has been said with regard to expenditure upon gold mines applies—only on a very much less extensive scale—to other mines—diamond, iron, and coal.

The important discoveries of diamond-bearing ground in the neighbourhood of Pretoria will create a demand for hauling, sorting, and washing plant, and all the minor machinery requisite for the industry.

With regard to iron, the development of the great deposits in the Middleburg district has hardly begun yet, but it is expected that a start will be made at an early date, and indeed plans to erect are now under consideration. The exploitation of these deposits ought to afford many opportunities for the supply of plant and machinery.

In the case of coal, the extension of the industry is entirely dependent upon an increase of demand.

RAILWAY EXTENSION.

The schemes for railway extension are, as might be expected, of the most ambitious character. They are of so much interest and importance to British trade that they are described in some detail. Immediately they offer a field for British enterprise and for the investment of British capital, as well as create a large demand for rails, rolling stock, and railway stores. Eventually they will materially modify the channels of trade, and powerfully influence the rapid development of the country, upon which trade ultimately depends for its expansion.

The railway extension in the various Colonies necessarily involves a constantly increasing importation of railway stores of all kinds, other than rolling stock, such as rails, points and crossings, bridge material, water-pipes and fittings, tanks, building material, oils, iron and steel, copper and brass, wagon-covers, electrical machinery and appliances, stationery, uniforms, and a thousand and one miscellaneous items.

It also implies the enlargement of fitting shops, foundries, etc., with their necessary equipment of machine tools, pneumatic tools, electric power and lighting machinery, all of which can and ought to be supplied from Great Britain.

Since the transfer of the Netherlands Railway to the Government of the new Colonies, all the orders for railway material which formerly went almost entirely to foreign countries come to Great Britain. It is estimated that close upon £3,000,000 has been spent in Great Britain upon rolling stock for these two Colonies since the British occupation, and that from £500,000 to £800,000 per annum will be so spent for some years to come.

If to this be added the additional material and rolling stock required for Cape Colony and Natal, not to mention Rhodesia, it will be seen how great a market the future offers to our manufacturers.

PUBLIC WORKS.

The large number of projected public works offer numerous openings for trade. Only second in importance to railway development is the improvement of dock and harbour accommodation, for if the railways have failed to meet traffic requirements during the past two years, the landing and handling facilities at the ports have proved themselves equally inadequate, in spite of the able and zealous labours of the various controlling bodies. In order to remedy this and to provide for the future, the Colonial Governments have voted liberal sums for harbour improvements. A huge scheme of extension and reconstruction is being carried out at Table Bay and lesser schemes are in progress at Mossel Bay, Algoa Bay, and East London, involving an expenditure of over £3,000,000; while the Natal Government is also considering a great plan for the entire re-organisation of the docks and harbour of Port Natal at an ultimate cost of two or three millions. Many important contracts have been placed in connection with some of these works, and many others remain to be placed. They cover cement, electrical and hydraulic cranes and other machinery, central electrical stations, barges lighters, trucks, and rails, machine tools for the shops, and many other items. In the present state of Colonial feeling, it is likely that the whole of these contracts will be placed in Great Britain. Other public works, especially in the new Colonies, include Government offices and buildings of all kinds, roads and bridges, prisons and police barracks, asylums, hospitals, telegraphs, schools, irrigation works, etc. In all cases building materials will have to be imported, corrugated iron, builders, hardware, fittings and furniture, and for irrigation works, pumps, machinery, pipes, etc.

There are few branches of Colonial activity which afford so many opportunities for the expansion of trade as the many necessary and pressing schemes for municipal improvement which are engaging attention in all the Colonies.

The Johannesburg Town Council has sanctioned the execution of an extensive scheme of sewerage and surface water drainage, involving an expenditure of between £500,000 and £600,000.

The system adopted for the sewerage is the gravitation water carriage system, the surface-water being treated separately. The probability is that the bulk of the material and appliances will have to be imported, such as cement of the very best quality, earthenware pipes, lead piping, iron tubes with vitrified enamel lining for soil pipes, iron manholes, etc. An interesting question arises with regard to earthenware and concrete pipes. Owing to heavy freight charges and to exceptional waste by breakages, it is important that they should, if possible, be made locally. The point is whether it would pay an English contractor to put down a plant for their manufacture in the neighbourhood of Johannesburg. The value of the pipes for this particular undertaking would probably reach £100,000, and in view of the fact that Pretoria and other towns have sanitation schemes under consideration, it is likely that there will be a large and continuous demand for some time to come.

As soon as the sewerage system is in operation and the water-supply is increased, there will undoubtedly be a large market for British sanitary goods.

A very large scheme for electric lighting power and tramways has also been decided upon. The estimated outlay is about £1,240,000, but it will probably exceed that sum. The equipment includes gas producers, engines, dynamos, station accessories, distributing mains and feeders, street lighting mains, lamps, rails, cables, overhead trolley wire construction, etc., etc.

The Rand water supply is a still larger undertaking than the two previously named. Its complete execution is expected to cost something like £4,000,000. In carrying out so large a scheme immense quantities of cement, steel mains, pumping machinery, etc., will be wanted.

Among other municipal undertakings in Johannesburg may be mentioned fire stations and abattoirs. For the latter transporters will be required for handling the carcasses. Destructors, road locomotives, and steam rollers will also be wanted.

To sum up, there is in sight in the new Colonies alone an expenditure upon public and municipal works of from £10,000,000 to £15,000,000, and upon railways of about £10,000,000.

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OUR MONTHLY SUMMARY.

LONDON, November 23rd, 1903.

The Institution of Civil Engineers and its new President.

When a naval constructor of Sir William White's antecedents and genius sets himself to talk to engineers collectively in the light of experience it is to be expected that something of more than ordinary interest will be given to the technical world. The address recently delivered by the new President of the Institution of Civil Engineers, presented with characteristic thoroughness, a comprehensive view of the progress and development of shipbuilding and engineering during the last forty-four years. A brief account of some of the points covered will be found in another part of the Magazine. Here we would allude to that portion which dealt with the work of the Institution. Sir William White remarked that—after eighty-five years of strenuous existence—it maintained its vitality unimpaired. Judged by the common standard of the length of its roll, the Institution flourished, but greater weight attached to the individual qualification essential to membership than to mere numbers; and measured by that standard, much progress had been made in recent years. The introduction of a system of qualifying examinations for admission of students and associate members was comparatively recent. The system had been gradually developed during the last fourteen years, and it had received constant thought and attention from the Council and officers. It was desired that young men entering the profession should be equipped with a sound general education before they commenced their special scientific and practical training. Moreover, the Council insisted upon the necessity for practical qualifications as well as for theoretical attainments, the former being proved by a period of actual work under experienced engineers, the latter being tested by examination. Complaints such as were heard during the earlier years of the examinations, arose chiefly from the want of due preparation by candidates, and had now almost ceased. Certain difficulties of an administrative nature remained in regard to the examination of candidates in foreign countries; but these were temporary, as students would more or less realise the necessity for qualifying themselves for admission before going to the Colonies or foreign countries.

The general position might be summarised in the statement that by this system the Institution was inculcating, in a student class, close upon 1,000 strong, the principles it had evolved with regard to engineering training. The Council was of opinion that to produce such a man practical training and scientific education were both essential. The hallmark of its membership, under existing conditions, was a proof of competence in both directions.

The Benevolent Fund.

Sir William White also made an appeal for the benevolent fund. "In this connection" he said, "it will be of interest to mention what has been for some months past an open secret. Mr. A. Yarrow, member of Council, has generously offered to place under the control of the Council of the Institution the magnificently equipped and endowed Convalescent Home for Children which he has established at Broadstairs, and carried on with marked success for seven years.

The arrangements for the transfer of such an establishment necessarily involve many important details which are receiving consideration. Our best thanks are due to Mr. Yarrow for this great mark of confidence, and for the proposal to place in the hands of the Council this means of ministering to the needs of the children of men in or associated with the engineering profession. It will be of great assistance to the work of the benevolent fund."

In the course of further preliminary remarks, the President mentioned that the date of the forthcoming visit, in 1904, to the United States would be fixed so as to enable those of the party who desire to do so to take part in the International Engineering Congress which is to be held at St. Louis early in October. Details for the visit have still to be worked out, and this will form one of the occupations of the session.

The Electrical Engineers and Decentralisation.

Another notable presidential address during the month was that which Mr. R. K. Gray delivered to the members of the Institution of Electrical Engineers. In addition to a general survey of progress which can scarcely fail to be of great utility both as a record and an incentive to further effort in the various fields of science and industry covered, the President made some remarks on the future of the Institution, from which it seems likely that, as time goes on, more and more attention will be given at its meetings to technical rather than to general subjects. At the close of the address he alluded to the tendency among manufacturers of electrical appliances to migrate from London to the provinces. Such a migration, from a general point of view was perhaps advantageous; but it indirectly affected the Institution in a way which was not of advantage to the central body. If the migration continued to the same extent as took place in the case of London shipbuilding many years ago, the centre of production, so to speak, of the electrical industry would gradually gravitate northwards, and nothing but consumers would be left in the metropolis. Many of our ablest members were already in the provinces, and it was quite a question for the Institution to consider whether the day was not fast approaching when they should extend their system of decentralisation. Was it not time that they should consider the establishing of a local section in London, similar in all respects to the local sections they had in Birmingham, Dublin, Glasgow, Leeds, Manchester, and Newcastle? In this new local section Papers affecting London could be read, and be published or not in the *Journal* of the Institution in the same manner as papers in the other local sections were dealt with. London would continue to be the headquarters of the Institution, and Institution meetings could be held, say, four times a year. At these, Papers of general interest could be contributed. If any such scheme as this were adopted, the constitution of the Council of the Institution would be somewhat affected. The chairman and committee of the London local section would, of course, be all London men; but the Institution would have a larger field from which to select its President and Council, as men who had their business in the provinces, and who could not spare the time to attend the present numerous Council and Institution meetings, might be able to attend the less numerous meetings which would be the outcome of some such re-arrangement.

Two Appointments and a Title.

Our congratulations are offered to Sir Clement le Neve Foster upon his knighthood. A brief account of the career of this distinguished mining expert will be found in another part of the Magazine.

During the month the services of Professor H. S. Hele-Shaw have been requisitioned through the Colonial Office to organise technical education in the Transvaal and Orange River Colony. It is safe to assert that for this highly important and onerous task no better man could have been found. The appointment is a very significant one, and there is far more in it than appears on the surface, but we shall not be surprised if Professor Hele-Shaw goes quietly into the work without any great flourish of trumpets; the results will be seen anon. In the meantime, in proof of Professor Hele-Shaw's capabilities as an organiser, one has only to look back on his successful efforts at the University of Liverpool. After eighteen years of work, which he commenced single-handed, he has now succeeded in organising an engineering faculty which consists of upwards of twenty members. As an American business man once said, "It is a very poor show that will not run itself for a few months by its own inertia." The session is started; the whole work is in full swing, and it will not, of course, be interrupted by Professor Hele-Shaw's temporary absence. An assistant lecturer will be appointed to give his lectures, making four good lectures in this department, as well as competent junior lecturers and other assistants.

Another notable appointment has fallen to Admiral Sir John Fisher, who recently produced a series of miniature earthquakes in the course of his experiments at Portsmouth. He is joining Lord Esher and Colonel Sir G. S. Clarke (the present Governor of Victoria) to serve on a committee to advise as to the creation of a Board for the administrative business of the War Office, and as to the consequential changes thereby involved. It is very satisfactory to find that some of the most acute intellects of the country are being brought to bear upon this vital question, and Sir John Fisher's appointment is particularly welcome on account of his very able work in the Navy and at Portsmouth.

The Dominating Feature in the South African Situation.

We recommend every engineer who is in any way interested in extending his business in South Africa to procure a copy of Mr. Henry Birchenough's report on the present position and future prospects of British trade in South Africa. A brief abstract from the most interesting section of this report dealing with new openings for trade is given in another part of the Magazine. Mr. Birchenough does not deal at any length with the labour question, but he shows convincingly that the provision of an adequate supply of labour is the dominating feature in the present situation. "It would be a great mistake to suppose it is only a mining question. Native labour is equally necessary for railway extension, Government and municipal works, building operations, private enterprise, and for agriculture. No rapid development is possible in any single direction without it. And the difficulty of the situation is increased by the fact that, if labour is diverted from the mines in order to press forward other branches of industry or public works, the flow of wealth upon which the country depends for its development, is *pro tanto* checked. The mines must be supplied first of all, since they are the pivot upon which general prosperity turns. It can hardly be wondered at if men from all classes, believing that this one need stands between the present moderate progress and the most amazing expansion, should wish to make a short cut and seek labour wherever it can be found.

Meanwhile the difficulty is proving in one respect a blessing in disguise, for it is stimulating the introduction of labour-saving appliances of all kinds, especially in the direction of mechanical transport, with the result that whereas the proportion of blacks to whites before the war was seven to one, it is now reduced to five to one. Thus the labour that comes in can be spread over a wider area.

During the present year, and especially during the last few months, the native recruiting returns have on the whole been decidedly more satisfactory, and there is reason to believe that before another twelve months have elapsed the goal will be in sight of restoring the gold industry to at least as high a level as it attained before the war. Even that would only mark the completion of the first stage of progress, because the old highwater mark is in no sense an end ; it is indeed only the starting-point of real and possible expansion. What is needed is patience and courage, but especially patience.

The real danger of the situation lies in the prolongation of the present financial strain. May not capital grow weary of waiting for a return, which seems so long delayed, and seek other channels ? Speedy relief is desirable, not only for the financial groups, which have to bear the heavy interest charges of the nonproducing mines, but in the interest of the whole industrial and commercial development of the Transvaal. It is really a race against time, and that is why experiments, however well meaning, which take years to show their results, are impracticable. The interests at stake, which are not merely those of the financial groups, but the whole of the industrial and commercial interests of the Transvaal, are too important for it to be allowed to stand indefinitely in the way."

Report of the Native Labour Commission.

As we go to press, the findings of the Labour Commission are to hand, as follows :—

First, the demand for native labour for agriculture in the Transvaal is largely in excess of the present supply, and as the development of the country proceeds this demand will greatly increase.

Secondly, the demand for native labour in the Transvaal for the mining industry is in excess of the present supply by about 129,000 labourers, and, while no complete *data* as to the future requirements of the whole industry are obtainable, it is estimated that the mines on the Witwatersrand alone will require within the next five years an additional supply of 196,000 labourers.

Thirdly, the demand for native labour for other Transvaal industries, including railways, is greatly in excess of the present supply, and will increase concurrently with the advancement of mining and agriculture.

Fourthly, there is no adequate supply of labour in Central or Southern Africa to meet the above requirements.

In all, 14,056 questions were answered by the 92 witnesses. The Commission find that at least 80,000 natives are wanted immediately for agriculture, and 40,000 for railways. They are of opinion that the evidence of the past is overwhelmingly and conclusively against the contention that white labour can successfully compete with black in the lower fields of manual industry. Great divergence of opinion existed among the witnesses as to the possibility of improving the labour supply from sources within the area of reference by legislative or other action, but in the opinion of the Commission none of these remedial measures offer a practical solution of the problem.

The report of the Commission being a foregone conclusion, no time will be lost by the Chamber of Mines. Government will be requested to authorise the importation of Chinese labour, and in the meantime, negotiations will be opened up in China in order that the necessary delay in making the great experiment may be curtailed as much as possible.

Lord Kelvin on University Training.

November 12th, was a notable day in the history of the South Wales Institute of Engineers, Lord Kelvin being admitted an honorary member, and with Lord Windsor (First Commissioner of Works) and Lord Tredegar, signing the roll in the presence of a representative gathering. Unfortunately, the President of the Institute, Mr. T. Hurri Riches, M.Inst.C.E., M.I.Mech.E., was unable to take the chair on account of ill-health Lord Kelvin, in returning thanks for his election, made some interesting remarks on the subject of University training. He believed engineers all over the world had still a good deal to learn in respect to the value of University education. He recalled the time when a youth just out of school —and he was typical of many in Glasgow—rising at five in the morning, donning his fustian jacket, and getting to the workshop by six o'clock. In those days workmen worked from six to six. There was no distinction between him and the ordinary workmen. He wore the same kind of fustian jacket, and the same sort of neckerchief as those with whom he associated, and was subject to the same rules and conditions. He served a five years' apprenticeship gaining valuable practical knowledge, learning the ways of the workmen, learning to sympathise with them, and seeing also how much they lacked for want of scientific knowledge, in order to make really effective overseers and foremen. It was in this respect that Germany and France had achieved such admirable results. He was not going to make comparisons, but he did say that the Germans particularly had learned how to educate their foremen. It would be impracticable for the ordinary workman to go through a scientific training, but every overseer and foreman of an engineering shop ought to do so.

Desiderata for the Young Engineer.

Every young man who desired to be an engineer, and not merely a daily workman, must learn the ways of workmen and also have scientific knowledge. How was he to get this ? Well, one way was for employers to take pupil apprentices on such conditions that they would be able to continue in scientific work at the University. Either a student must be all University and no practice, or all practice and no University. The system of combining University training and workshop practice was not yet sufficiently understood or appreciated. It used to be said no employer would take an apprentice unless he was prepared to go on from year's end to year's end ; it was not convenient for a dozen young fellows to leave their work to attend a University. Well, there was a good deal to be said on that subject. The Institution of Civil Engineers in London was by no means behind in its appreciation of the importance of University education, or education of the kind that ought to be given at a University, and it had gone so far as to institute examinations. Examinations were very good in their way, provided they connoted the work of preparation for the examinations. There must be capable teaching, and there must be learning of science before a man could be a thorough engineer—whether civil or mechanical engineer—capable of guiding and doing the world's work in the applications of science for the benefit of man. Well, he would suggest—it was not a new suggestion—that employers should put themselves to some slight inconvenience in taking as pupil-apprentices young men of a class qualified to become in time master-engineers, taking them for half the year, and leaving them free for University work for the other half. He did not think half a day at the University and half a day in the workshop would work out right. Lord Kelvin also commended the good work done by the University College of South Wales, under the guiding hand of Principal Griffiths, to whose research work he paid a warm tribute. He hoped that after a year or two of the arduous labours of his present office, the latter would be able to return to his laboratory and continue in the same good work of scientific research.

London University and its Aims.

In the course of a lecture on London University and its aims Sir Arthur Rücker (the Principal) remarked that a modern university had to concern itself with teaching, with research, and with technology. Since 1900 the number of persons who had entered the University in a year had risen from 1,890 to 2,900, while in the intermediate examination the numbers had increased from 703 to 1,014. But, though much had been done, much remained to be done. It was essential, in carrying on the work, that the efforts of the University should, at particular times, be concentrated on particular objects, and at present three schemes had been proposed. For two of them large resources had been accumulated, but not one of the schemes could be carried out until those resources had been augmented. The first of these was the incorporation of University College, which had offered to place its whole property at the disposal of the University, and under its control. The University would thus be made at a stroke the greatest teaching body in London, and its position as a teaching University, and not a mere [illegible] between competing colleges would be secured. In order to carry out this scheme [illegible] was needed to make the college ready for incorporation. The Drapers' Company had given £30,000 for this object, and altogether about [illegible] had been raised. But the scheme was delayed for the want of [illegible]. The second scheme was connected with the great medical schools of London. They were at present hampered by the necessity of providing education in subjects such as physics and chemistry, which could be equally well taught at a distance from a hospital, and they were anxious that the University should undertake the whole of that work. This proposal would co-ordinate teaching in London, and a beginning could be made if £100,000 were provided.

The third scheme was proposed by Lord Rosebery, who, all members of the University were pleased to know, was still to remain their Chancellor. It was understood that about £100,000 more was needed to carry out this plan also. It would probably be impossible to concentrate the whole of the advanced teaching [illegible] [illegible] [illegible] The existing institutions at South Kensington, the near neighbourhood of the scientific and technical museums of the Government and of the University itself, made South Kensington the most appropriate site, and it might surely be hoped that the comparatively small sum now wanted to bind all existing agencies together would before long be found.

Value of the Berlin-Zossen Experiments.

In our German Résumé will be found an account of the further experiments on the experimental line between Berlin and Zossen. The experimenters appear to have attained a speed of 130 miles an hour, and with this they are apparently, for the time being, content.

As to the value of these experiments, a good deal of difference in opinion not unnaturally prevails. It is said that the engineers were hopeful that American capitalists would take the matter up, and put it to practical use. They argue that the great boldness of American capitalists and the intense economic life in the Eastern States offer exceptional prospects for building the first successful high-speeding roads. Germany is too poor and too little developed to take the matter up at present. One of Emperor William's ideas is an electric road between Berlin and Hamburg. His Majesty has shown the deepest interest in the Marienfelde-Zossen experiments throughout.

One turns with interest to expressions of opinion in the American press. The *Iron Age* points out that the speed in question is the least part of the problem; much the larger part is found in the limitations which at present hedge round the engineer in providing a permanent way suitable for such speeds and maintaining it summer and winter, in building rolling stock of such perfection that it will be durable under the excessive strains of such exaggerated train acceleration, and in inducing passengers to pay the rates of fare which must be charged to make such a railroad profitable to those who build and operate it.

Divergent Views.

This journal further remarks that it would be a very foolish employment of capital to try now to apply in practical railroading the German results on the Marienfelde-Zossen line, which really established nothing of value. They are interesting, of course, and may have repaid those who made them in honours and advertising, but in practical railroading revolutionary results may safely be regarded with suspicion. Ballast, ties, spikes, fish plates, rails, wheels, axles, switches, cars, signals, a hundred items of railroad construction and equipment, must all be brought up to the standard of the motor mechanism, and until this is done the latter will have more of scientific than of practical interest. On the other hand, a special cable message from Berlin reports that Dr. H. S. Pritchett, president of the Massachusetts Institute of Technology, had the distinction of being the first foreigner to ride on the motor cars used in the high-speed electrical experiments on the Marienfelde-Zossen military railroad, and from the observations which he made and from the figures submitted by the engineers, Dr. Pritchett does not doubt the commercial success of the motors up to a speed of 100 miles. He thinks that on roads between cities like New York and Washington, with low grades, few curves and heavily ballasted, a cheap system of electric traction would undoubtedly prove commercially profitable. Dr. Pritchett regards a speed above a hundred miles [illegible] perhaps unprofitable owing to the great expense of each additional mile. At any rate, Dr. Pritchett says it is a great mistake to regard the Marienfelde-Zossen experiments as a mere scientific curiosity. Practical results of an important character will certainly follow.

In the meantime there can be little doubt as to the value of these costly and dangerous experiments for the establishment of data on such questions as the powers and limitations of electrical equipment, wind resistance, etc.

NAVAL NOTES.

MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT,

BY

N. I. D.

GREAT BRITAIN.

IN the issue for November, I gave a table showing the ships built, building, and projected for the principal countries. This table differed very slightly from that which was published officially in the previous March, but it showed the progress made during the year, for five of the first-class battleships building according to the official document have now been added to the list of those built. To the list of projected I added three, and since that was done those three vessels have been put in hand at the public yards, and they have received their names. It is not quite clear why the Admiralty decided to hasten the laying down of these three vessels, but it is very satisfactory that it should be done. Discussion has, however, been aroused by an announcement that these vessels are to be of similar design to the *King Edward VII*. This was found to be hardly correct, since important modifications in that design have been introduced, but not sufficient to make these vessels of a different class. Indeed, it may be said that practically in power of offence and defence they are similar. These three vessels are to be named the *Britannia*, to be laid down at Portsmouth; the *Hibernia*, at Devonport; and the *Africa*, at Chatham.

Turning to the armoured cruisers, it will have been noticed from the tables above referred to that six have been transferred from the building to the built category. Contracts have been placed and names allotted to the four vessels in the projected list, of which the type ship is the *Duke of Edinburgh*. The *Duke of Edinburgh* was first given for a sister the *Black Prince*, building at Blackwall; these two vessels have now added to them the four belonging to the programme of 1903-4. These vessels are the *Warrior*, laid down to Pembroke; the *Achilles*, to be built at Elswick; the *Natal*, to be built at Barrow; and the *Cochrane*, by the Fairfield Company on the Clyde. Three more cruisers of the *Devonshire* class have been put into the water. These are the *Hampshire*, at Elswick, on September 27th; the *Carnarvon*, from the yard of Messrs. Beardmore and Co., at Govan, on October 7th; and the *Antrim* from Brown's yard at Clydebank, on October 8th. This leaves three more of the class to be launched, the *Devonshire*, at Chatham; the *Argyll*, at the Greenock Foundry; and the *Roxburgh*, at the London and Glasgow Company's yard.

There are three projected cruisers in the programme of 1903-4, but there is some doubt as to whether these vessels will be built since the lessons of the manœuvres this year are said to have indicated that small cruisers such as these are of no account except for patrolling purposes in times of peace. In any case, tenders had not been invited up to the end of November. With the four scouts of this year's programme mentioned in the issue for September as having been allotted to the same firms as already have similar vessels under construction, the names have now been made public. Elswick, where the *Adventure* is building, is to build the *Attentive*; Vickers, who are building the *Sentinel*, are to build the *Skirmisher*; the Fairfield Company, now building the *Forward*, will build the *Foresight*; and Laird's yard, where the *Pathfinder* is in hand, will undertake the *Patrol*. As these vessels, like their earlier sisters, are to be of the design of their builders, there is some difference in their displacement and horse-power, but they are all to have the speed of 25 knots.

The last two items in this year's programme are the destroyers and the submarines. The new submarines, like all those previously built for the British Navy, will be constructed at Barrow by the Vickers firm. They are ten in number. Thirteen destroyers of 25·5 knots have been ordered. Three, the *Swale*, the *Ure*, and the *Wear*, from Palmers'; three, the *Liffey*, the *Moy*, and the *Ouse*, from Laird's; three, the *Boyne*, the *Doon*, and the *Kale*, from Hawthorn's; two, the *Gala* and the *Garry*, from Yarrow; and two, the *Chelmer* and the *Colne*, from Thorneycrofts'.

FRANCE.

In the French table shown in the November issue the changes from the official return showed that, as far as battleships were concerned, one of those in the building list had been transferred to the built category in the first class, and similarly one in the second class. These vessels are the *Suffren* and *Henri IV*. Six battleships remain in the building list. These are the *République*, *Patrie*, *Liberté*, *Démocratie*, *Justice*, *Vérité*. In the design of these last four vessels several changes have been introduced, which while they will undoubtedly add to their strength, they must retard their progress, and will not make for homogeneity aimed at in the British fleets and squadrons. The secondary batteries of these ships will consist, instead of the original eighteen 6·4-in. guns, of ten 7·6-in., and eight 3·9-in. The disposition of this battery is also altered; instead of there being six turrets each with a couple of 6·4-in. guns as in the *République*, these turrets will each mount one 7·6-in., and four other guns of the same calibre will be carried in the casemate. Of these vessels, the *Liberté* is officially to be completed in 1906 and the *Démocratie* and *Vérité* in 1907.

Turning to the armoured cruisers, it will be noticed from the tables that two have been transferred from the building category to the list of those built, and since then five more have been completed. This makes in the built list sixteen. The vessels added are the *Marseillaise*, *Dupleix*, *Sully*, *Amiral Aube*, *Desaix*, *Gloire*, and *Kléber*. This leaves six building; these are the *Jules Ferry*, launched in August; the *Léon Gambetta*, *Dupetit Thouars*, and *Condé*, all to be completed next year—the *Victor Hugo*, and the *Jules Michelet*. There is still one projected ship, the *Ernest Renan*,

Of torpedo-boat destroyers, the fourteen in the built list have now become twenty-six, the following vessels having been added to this category, *Arquebuse*, *Arbalète*, *Arc*, *Bombarde*, *Carabine*, *Catapulte*, *Epieu*, *Javeline*, *Mousquet*, *Mousqueton*, *Pistolet* and *Sabretache*. This leaves in the list of building twelve, which includes four of the programme of 1903-4. With regard to torpedo-boats, there were altogether in the programme on 1902-3 and 1903-4 forty-three boats. Of these, thirteen were ordered early this year, and recently tenders have been invited for twenty-one more. These vessels are to be of 97 tons displacement, with length 92 ft., beam 13·9 ft., draught 9 ft., engines 2,000 h.p., speed 26 knots, complement, two officers and 21 men. They are to carry two 27-mm. guns, and one fixed torpedo tube in the bows, and two tubes on pivots aft.

The Estimates for 1904, as briefly stated in the last issue, have been submitted to the Chamber of Deputies, accompanied by the usual appendices, giving details of expenditure and its progressive increase for different departments. The estimates total 312,931,832 frs. (£12,517,273), which, as compared with that for the previous year, shows a reduction of 539,692 frs. (£21,585). The report calls attention to the somewhat difficult problem to be solved by the Administration. While the condition of the finances imposes economy, the continued increase in the estimates of the principal naval Powers renders it impossible to reduce the sums allocated to naval defence. Furthermore, the launching of new vessels is a source of enhanced expenditure for the department. An economy has been effected by the suppression of useless machinery in the central administration, by the revision of certain allowances, and by the adoption of a better system of keeping the accounts. The greater part of the expenditure being absorbed by armaments, it is considered necessary that these should not be exaggerated. Next year the Far Eastern squadron will include three modern armoured cruisers and three protected cruisers. The Atlantic division will comprise an armoured cruiser, together with one first-class and one third-class cruiser. The Northern squadron will be composed of a division of ironclads, a division of coastguard vessels, and a division of armoured cruisers. The Mediterranean squadron will continue to consist of two divisions of ironclads, a division of armoured cruisers, and a division of protected cruisers. There is a total of 113,712,127 frs. for new constructions, of which 10,026,057 frs. will be applied to the completion of vessels of the old programme, the construction of which has been delayed. The only vessel of any great importance to be commenced next year is a cruiser which, it is said, while sacrificing nothing of the strength of its predecessors, will have the greatest possible increase of speed. A reduced number of submersibles will be put upon the stocks in order to hasten their completion. These vessels will be of larger tonnage than heretofore. Another category of expenditure is that upon the *points d'appui*, or coaling stations. Next year the expenditure at Bizerta will be reduced to 7,500,000 frs. A total of 4,600,000 frs, has been allocated to colonial naval stations, of which the largest separate item is 2,500 000 frs., to be expended at Dakar.

GERMANY.

In the lists of German ships, the vessel added to the official list is the *Mecklenburg*, leaving seven instead of eight vessels building; these are *Schwaben, Braunschweig, Elsass, Lothringen, Hessen, Preussen*, and N. All these vessels have been launched except the *Lothringen* and N., which is building at Kiel, and is slightly larger than the others, and intended to carry a heavier secondary battery. The *Hessen* was launched at Kiel on September 18th, and the *Preussen* from the yard of the Vulcan Company on October 31st. Both these vessels are of the *Braunschweig* class. The main dimensions are as follow: Length between perpendiculars, 121·50 metres (398 ft. 7.5 in.); breadth over armour, 22·20 metres (72 ft. 10 in.); depth from keel to middle of upper deck, 13·04 metres (42 ft. 9·4 in.); draught, 7·65 metres (23 ft. 1 in.). The crew number 700. The normal coal-bunker capacity is 700 tons, the maximum being 1,600 tons; while a large quantity of oil-fuel can be accommodated in the double-bottom spaces. The vessel is constructed of Siemens-Martin steel. She has a water-tight cellular bottom, extending up the sides of the ship to where the protected deck is connected to the armour belt. There are fifteen water-tight transverse bulkheads. The armour protection consists of belt and citadel plating, armoured gun-turrets, conning towers, and protected deck. The thickness of the belt armour varies — the maximum amidships being 225 m.m. (8·85 in.) and 100 m.m. (3·94 in) at the ends. The citadel plating above the belt has a thickness of 140 m.m. (5·51 in.). The plates for the barbettes vary between 250 m.m (9·84 in.) and 170 m.m. (6·69 in.). For the two conning towers the maximum thickness of plates is in one tower 300 m.m. (11·81 in.), and in the other 140 m.m, (5·51 in.). The surface of the plates exposed to direct fire is hardened by the Krupp process. The armament is made up of four 28-c.m. (11·02 in.) breechloading guns, ten 17-c.m. (6·69 in.) quick-firers, ten 8·8-c.m. (3·15 in.) quick-firing shielded guns, twelve 37-m.m. machine-gun (unshielded). There are six torpedo-launching tubes —one at the bow, four on the broadside, and one at the stern. These are below water-line, and fire 45-c.m. (17·72-in.) torpedoes. The propulsion of the ship is by three screws, the centre one being four-bladed, the others three-bladed. Each screw is driven by a separate engine of the triple-compound type. The vessel has six cylindrical and eight water-tube boilers, contained in three separate compartments, with three funnels.

Turning to armoured cruisers, these remain as in the official list, and of the four in hand the *Friedrich Karl*, *Prinz Adalbert*, and *Roon* will soon be completed, while the *Ersatz Deutschland* has not yet been launched. Of the protected cruisers, the *Arcona* should be completed shortly, the *Undine*, *Hamburg*, *Bremen*, and *Berlin* (*Ersatz Zieten*) have been launched, and the *M.* and *Ersatz Mercur* have been recently laid down.

The German Naval Estimates for 1904, as proposed. are 225,300,000 marks (£11,265,000). For new construction it is proposed to spend 71,055,000 marks (£3,552,750), half of which is to be raised by loan, and the remainder charged to the Navy Estimates.

RUSSIA.

According to the official list. the strength of battleships of the first-class built, building and projected, stood respectively at 13, 8, 0. Since then from the building list, two, the *Ossliabia* and *Cesarevitch* have been added to the number of those completed. Two more, the *Ioann Zlatoust* and *Evstafi*, of 12,000 tons displacement, have been laid down in the Black Sea yards, bringing up the building number to eight, and in addition to this, two other vessels are to be built in the Baltic. These, of 16,630 tons each, are to receive the following names: that at the Baltic works the *Imperator Paval I.* (*Paul I.*), and that at Galernii Island, the *Andrei Pervozvanni* (*Andrew the Apostle*). The two Black Sea ships are also named after saints in the Orthodox Calendar, and are sometimes spoken of in the papers as the *Eustathius* and *St. John Chrysostom*. They are building respectively at Nicolaeff and Sevastopol. Unless the progress of these four vessels should be very much accelerated, they can hardly be ready for use before 1908-09.

Naval Notes.

The Russians have now eight so-called armoured cruisers completed, although some of these scarcely deserve the name. The last to be completed is the *Bayan*. It has been reported that six, or according to some accounts, three, more armoured crusers are to be put in hand. But nothing is yet known officially on this head. There is one vacant slip only, in the Russian dockyards, and one might be laid down on this.

Of protected cruisers, Russia is still a builder, and is about to lay two more in the Black Sea of the type of the *Kagul* and *Otchakoff*. The *Izumrud* was launched at the Neva works in October, and both this vessel and her sister, the *Jemchug*, are to be sent to the Far East when ready.

At St. Petersburg, also, a gunboat, the *Khivinets*, is building for service in the Persian Gulf. Her length at the water-line is 220 ft.; beam, 37 ft.; draught, 10 ft. 0 in.; displacement, 1,316 tons; speed, 13 knots; armament, two 4·7-in. and eight 2·95-in. with four machine guns in the fighting tops. She is to carry two hundred men and officers

ITALY.

The only alterations of importance in the list of the Italian Navy concerns the two battleships of the six building which have been recently launched; the *Roma*, of 12,620 tons, took the water at Spezzia on September 20th, and the *Napoli*, of the same class, was launched on October 21st. The length of these vessels is 474·4 ft between perpendiculars, 435 ft. beam, 73·4 ft.; draught, 25·8 ft.; the engines are of 20,000 h.p., and the estimated speed is 22 knots. They will carry as their armament two 12-in., twelve 8-in. and twelve 3-in. guns, and twelve 1·85-in. guns, and four torpedo tubes, two of which are submerged. The greatest thickness of the armour belt is 9·8 in. The turrets for the heaviest guns have a protection of 7·86 in. The turrets of the 8-in. guns are protected with 5·9-in. armour; the bulkheads of the citadel are the same thickness; the armoured deck, 1·95 in.; and the conning tower 9·85 in. Three new battleships, of smaller displacement are projected.

Turning to the cruisers, a small vessel of 3,500 tons of the *Puglia* type is projected, but has not yet apparently been put in hand. The torpedo-boat destroyers and torpedo-boats have been laid down, and of the submarines one of the *Lorenti* type is under construction, and another one of the *Ruffini* type is to be in hand shortly.

UNITED STATES

Turning once more to the official list, we find battleships built number ten, to which may be added the *Ohio*, leaving eight building. These are the *Missouri*, *Nebraska*, *New Jersey*, *Georgia*, *Virginia*, *Rhode Island*, *Connecticut*, and *Louisiana*. In the programme of this year, five more are projected, *Vermont*, *Kansas*, *Minnesota*, *Idaho*, and *Mississippi*. The armoured cruisers remain, built two, building eleven. An attempt was made to launch the 15,000-ton armoured cruiser *Maryland* at the Newport News Company's works on September 13th, but she stuck on the ways, and it was not until the following week that they got her afloat.

The total amount of the Naval Estimates for the year ending June 30th, 1905, is $102,866,449, which shows an increase of $26,846,568 over the Appropriation for the current fiscal year. This increase is due in the main to the large additional amount required for the construction and for the armour and armament of vessels already authorised for new dry docks and other naval establishments, and for a larger coal bill. The following are the items:—

Pay of the Navy	$19,824,093
Pay, miscellaneous	600,000
Contingent, Navy	15,000
Emergency fund	50,000
Bureau of Navigation	1,363,886
Bureau of Ordnance	3,776,700
Bureau of Equipment	6,497,903
Bureau of Yards and Docks	922,884
Public Works, Bureau of Yards and Docks	8,164,874
Public Works, Bureau of Navigation, Naval Academy	3,000,000
Naval Training Station, Rhode Island	14,000
Naval War College	8,125
Naval Station, Great Lakes	250,000
Public Works, Bureau of Ordnance	248,900
Public Works, Bureau of Equipment	7,800
Public Works, Bureau of Medicine and Surgery	20,000
Bureau of Medicine and Surgery	360,000
Bureau of Supplies and Accounts	5,203,932
Bureau of Construction and Repair	8,595,824
Bureau of Steam Engineering	3,572,900
Naval Academy	314,588
Marine Corps—Paymaster	2,118,875
Quartermaster	1,690,290
Increase of the Navy—Construction and Machinery	28,826,860
Armour and armament	12,000,000
Equipment	400,000
Total	$102,866,449

MINOR NAVIES

Austria.—The full speed trials of the Austrian battleship *Babenberg* have been concluded with noteworthy results. According to contract, she was to make 18·5 knots with 136 revolutions, and engines developing 11,900 h.p. The official figures for the result of the trial state that she made 20·6 knots, her engines working at 149 revolutions, and the horse-power developed was 17,011. It must be an almost unique occurrence for engines to develop nearly fifty per cent. in excess of their anticipated power. The boilers are of the Belleville type, with economisers.

The battleship *Erzherzog Karl*, the largest ship in the Austrian Navy, was launched at Trieste on October 4th, in the presence of the Archduke and Archduchess Rainer. The naming ceremony was performed by the Archduchess Marie. This vessel and her sister also building at Trieste, but not yet launched, displace 10,600 tons, are 390½ ft. in length, and carry as principal armament four 9·4-in. guns. In addition, there are eight 7·5-in., and six 6-in. guns as secondary battery. The engines, which are to develop 14,000 h.p., will be supplied with steam by Yarrow boilers, and are expected to give a speed of 19 knots.

Turkey.—The new cruiser *Abdul Hamid*, sister to the *Abdul Medjid*, launched at Philadelphia earlier in the year, took the water at Elswick on September 25th. This vessel is of the protective deck type, has a length of 340 ft., and displaces 3,830 tons. The protective deck extends over the whole of her length, being 4 in. thick on the sloping parts, and 1½ in. thick on the horizontal parts. Numerous water-tight bulkheads extend to the upper deck, and the double bottom is sub-divided into a number of water-tight compartments. The principal armament consists of two 6-in. and eight 4·7-in. guns, Two 18-in. torpedo tubes are also fixed, above water. Messrs. Hawthorn, Leslie and Co., are the builders of the machinery, which is designed to produce 12,500 h.p., giving the vessel a speed of 22 knots.

LOCOMOTIVE ENGINEERING NOTES.

BY

CHARLES ROUS-MARTEN.

The New Atlantics.

All three of the latest express engines of the "Atlantic" or 4–4–2 type, built for British railways are now on the metals, and will soon be in regular work. They are, of course, No. 102 "La France," on the Great Western; No. 251 on the Great Northern and No. 532 on the North Eastern Railway. Each of the locomotives has been generally described in this portion of PAGE'S MAGAZINE, and it will be remembered that Great Western No. 102 is a four-cylinder compound of the de Glehn du Bousquet order, with 6 ft. 8 in. coupled wheels; cylinders, high-pressure (2) placed outside $13\frac{3}{8}$ in., and low pressure (2) placed inside $22\frac{1}{16}$ in.; $25\frac{1}{4}$ in. piston stroke, 2,325 square feet of heating surface and 228 lb. steam pressure, while Great Northern No. 251 is a non-compound high pressure engine with 6 ft. 7 in. coupled wheels; outside cylinders, $18\frac{3}{4}$ by 24, 2,500 square feet of heating surface, and 175 lb. steam pressure; and North-Eastern No. 532 is also of the high pressure non-compound class with 6 ft. 10 in. coupled wheels, outside cylinders 20 by 28, 2,500 square feet of heating surface, and 200 lb. steam pressure. It may be noted as a remarkable novelty that the two locomotives of British design have actually larger heating surface in their boilers than has the "Frenchman." But on the other hand it must be borne in mind that the boiler of the Great-Western engine has in ordinary working only to fill *two* $13\frac{3}{8}$ in. by $25\frac{1}{4}$ in. cylinders with "live" steam, whereas the cylinders which the Great Northern boiler has to fill are $18\frac{3}{4}$ by 24, while those of the North-Eastern have the colossal dimensions of 20 in. by 28 in. So possibly the French boiler may be deemed the largest after all, relatively to the demand which will be made upon it. Still the other two boilers are considerably in advance of any previously seen in this country, if only those supplied to the new Caledonian six-coupled express engines, Nos. 49 and 50, and to the eight-coupled goods type, "600" class on the same Scottish railway be excepted.

Boilers and Cylinders.

Naturally the latest discrepancy between the boiler and cylinder dimensions in the cases of the locomotives just mentioned, and of other engines of recent build, have excited much attention and comment in engineering circles. Taking the two British designed "Atlantics," Great Northern No. 251 and North-Eastern No. 532, the contrast is extraordinary. Both engines have boilers 5 ft. 6 in. in diameter with about 2,500 square feet of heating surface, and both are designed for work practically identical in class. Yet the one has cylinders only $18\frac{3}{4}$ in. in diameter with a 24 in. piston stroke, while the other has 20 in. cylinders with 28 in. piston stroke. It is true the North-Eastern engine has driving wheels of 3 in. greater diameter than those of the Great Northern locomotive so the disproportion is not quite so great as it would appear from citation of the cylinder dimensions only. For those cylinders will be filled and emptied proportionately with less frequency and consequently so much less steam will be used and needed. It may be anticipated, however, with considerable probability that ultimately the Great Northern engine will be fitted with much larger cylinders. For there is no doubt that the boiler could easily fill them, and so the power of the engine would be materially enhanced. During an experimental trip with Great Northern No. 251 made by the present writer, he found that the boiler furnished an abundance and even a superfluity of steam when a 250-ton train was hauled at an average speed of 57 miles an hour along a distance of 156 miles over a road possessing such gradients as 1 in 178, 1 in 198 and 1 in 200 for many miles, and even 1 in 100, 1 in 105, 1 in 110 and 1 in 150 for shorter distances. It would be very interesting to try how the cylinder dimensions 20 in. by 24 in. would answer as compared with 19 in. by 26 in. Either pair of dimensions has its advantages. Larger cylinders than these have still to be justified by their results.

North-Eastern Compound Experiences.

The North-Eastern, which definitely adopted compounding on the Worsdell-von Borries' system eighteen years ago and built a number of engines both express and goods on that system sufficient to stock two or three railways of more modest dimensions, now appears to have conclusively reverted to the non-compound method. For several years past the Worsdell-von Borries' compound passenger engines have steadily undergone conversion into the ordinary type. The handsome 7 ft. 7 in. single-wheelers which, when they first came out, some fourteen years ago, were loudly proclaimed as the greatest as well as the last thing out in express engines, were the first to go out of the compound ranks, and have long since been transformed into non compounds. So have the smaller 7 ft. 1 in. single wheelers which preceded those just mentioned, and also Nos. 1324, 340 and others among the list of 6 ft. 8 in. coupled compounds, which, when they made their appearance, were to revolutionise British locomotive practice. It is true that of late years the North-Eastern has tried one more experiment in compounding, a 7 ft. coupled engine constructed in all other respects to Mr. Wilson Worsdell's standard design, but built on his brother's two-cylinder compound system, having been rebuilt, not like the others as a non-compound, but as a three-cylinder compound of novel design. In her new guise, this engine, No. 1619, has now been running for some years with distinct success and has, under the observation of the present writer, done much excellent work. So far, however, its influence seems to have been felt on other territory than the North-Eastern. But before proceeding into that territory it is necessary to notice that the North-Eastern Worsdell-von Borries' compounds were the successors of a batch of express engines virtually identical in design, but with 7 ft. coupled wheels, previously constructed by Mr. T. W. Worsdell while he was Chief Mechanical Engineer of the Great Eastern Railway. All the engines of this batch, eleven in number, viz., 230 and 700–709, long have been converted by the present Locomotive Superintendent, Mr. J. Holden, into locomotives of the ordinary type. Not one compound now remains on the Great Eastern, and only one of what may be termed the modern order on the North-Eastern.

Locomotive Engineering Notes.

The Midland Compounds.

In the November number of this MAGAZINE (pp. 450 and 451) a description was given of the two compound engines designed by Mr S. W. Johnson, Locomotive Superintendent of the Midland Railway, and of some recent work performed by them under the present writer's observation. It will be remembered that those engines, Nos. 2631 and 2632, have 7 ft driving wheels four coupled, one high pressure cylinder 19 in. by 26 in. placed inside, and two low-pressure cylinders each 21 in. by 26 in. outside; also 1,508 square feet of heating surface and 195 lb. steam pressure. Now these engines do unmistakably show the direct influence of the North-Eastern engine No. 1619. They are constructed on the same general principle with one high-pressure cylinder of the same size, viz., 19 in. by 26 in., and two low-pressure cylinders outside of approximately similar dimensions to those of the North-Eastern engine. Herein, it may be observed, the London and North Western practice initiated by Mr. F. W. Webb is exactly reversed. He has two high-pressure cylinders placed outside, one low-pressure cylinder placed inside. The diametric oppositeness of these two methods offers a very direct and cogent instance of the extraordinary variety that exists in the ideas and the methods of some of our most distinguished railway engineers. Mr. Johnson, however, has proceeded with commendable caution. Until he had thoroughly tried and tested the first two of his compounds which may be said to differ one from the other merely in the fact that one has ordinary boiler tubes, while the other has the ribbed tubes of the Serve design he did not deem proper to expend the shareholders' money on the multiplication of the new type. He very properly waited until he should have satisfactorily proved the desirableness of such multiplication and the usefulness of the novel engine. In view of the work recorded on page 451 of last month's issue of this MAGAZINE which work, there is good reason to state does not at all stand alone in the record of these engines but has been equalled or closely approached over and over again during the time they have been in use, it is not surprising now to learn that the process of multiplication is already in action. Three more of the same type, Nos. 2633, 2634 and 2635 completing the batch provided for in the original order left the Derby shops early last month and are now doing regular duty on the main line. Two at any rate out of the three new ones are to run up to London (St. Pancras) and so will be accessible to the inspection of London engineers, many of whom have taken a warm interest in the new experiments in compounding.

Ratio of Dimensions.

It is impracticable within the limits of the present notes to attempt dealing exhaustively or, indeed, superficially with the vexed and difficult question of the best ratio between the dimensions of high- and low-pressure cylinders in compound locomotives. No two of the designers of such engines agree on this point, Monsieur Mallet, Mr. F. W. Webb, Mr. T. W. Worsdell, Herr von Borries, Monsieur de Glehn, Mr. J. Reikie, and Mr. S. W. Johnson, not to mention several other experimentalists in locomotive compounding, all hold different views in this respect. But there is another question of ratio upon which almost as great diversity of expert opinion seems to exist. That is the ratio between the boiler power and the dimensions of the high-pressure cylinders which have to be supplied with "live" steam. This point has already been touched upon in the course of the present notes, but it appears to need far more careful investigation than it has yet received; else it is difficult to believe that we should be met with such strangely dissimilar proportions as those of the Great Western and North Western compounds, respectively. MM. de Glehn and du Bousquet have deemed it needful to provide no less than 2,325 square feet of heating surface to fill a pair of 13⅜ in. high-pressure cylinders with "live" steam. Mr. Webb considered 1,370 square feet ample for the two 15 in. high pressure cylinders "of his Jubilee Class," while for his latest type of all with 16 in. high-pressure cylinders, he provided only 1,527 square feet of heating surface including, according to his own express statement, that afforded by the water-bottom which he fitted to the firebox and which can scarcely be regarded as equivalent to a like area of surface more favourably placed. It may be rash to assert as an absolute *sequitur* that one or other of these distinguished authorities must be in the wrong. In such cases as this there are always numerous important details which tend to modify the relative values of equal dimensions; the nature and disposition of heating surface may be cited as among the most prominent of such details. Mr. D. Drummond, for example, maintains that with his water tube boiler which must not be confounded with the ordinary boilers merely having water-tube fireboxes he can obtain as good results with 750 square feet of heating surface as he can get out of the ordinary boilers with 1,500. This, however, is by the way and is anticipating a topic to which attention will have to be devoted later. Looking, however, at the matter from the ordinary common sense view of the engineering "outsider" it would certainly appear that if the de Glehn du Bousquet 2,325 square feet of heating surface be needed for 13⅜ in. cylinders, then, presumably, Mr. Webb's 1,370 or 1,527 square feet can hardly be adequate for 15 or 16 in. cylinders. That *a priori* view would seem to be strongly borne out by the results of practical experience. It is understood that already it has been found advisable to line up the cylinders of the largest North Western compounds, bushing them to a diameter of 15 in., and it does not appear to be at all certain that even now the engines might not be improved by further diameter reduction; possibly a preferable expedient might be to put on them much larger boilers and it does not seem unlikely that this plan will be pursued in course of time. But the fact that it has been found necessary to make and carry out the hard-and-fast rule that even these engines when their load exceeds "seventeen coaches"—twelve-wheelers being reckoned as two, eight-wheelers as one and a-half, six-wheelers as one—must be assisted by a pilot, does seem to suggest that the practical experience of these massive and fine-looking engines has not inspired such confidence in their capacity as would warrant an exception to this rule being made in their favour. Nevertheless, the writer feels bound to say that his personal experience of their working leads him to believe that they are capable, without assistance, of much harder work than that which is at present allotted to them. It may also be added that experiments have been made with one of their number, 1952 "Benbow," by modifying the arrangement of the valve-gear, which have given such satisfactory results as to hold out good promise that at no distant date it may be found permissible to relax in their favour the "seventeen coach" piloting rule. It is, at any rate, to be hoped so.

THE MINING WORLD.

Accidents in Mines and Quarries.

A report issued by the Home Office gives statistics relating to persons employed and accidents at mines and quarries and to the enforcement of the Mines and Quarries Acts.

In 1902 there were employed at coal mines 651,505 persons underground and 159,282 above ground, and at iron mines 12,393 underground and 4,135 above ground. At other mines 28,288 persons were employed, and at quarries 97,108 persons.

There occurred in and about mines and quarries 1,061 separate fatal accidents, causing the loss of 1,172 lives, 1,053 at mines and 119 at quarries. These figures correspond to a death-rate of 1·23 per 1,000 employed at mines (the lowest rate yet recorded) and 1·23 per 1,000 at quarries. Taking underground workers separately, the death-rate from accidents at mines was 1·370 per 1,000 employed, while for surface workers the rate was 0·687 per 1,000.

In 1902 there were seventy-three prosecutions of owners, agents and managers for offences under the Coal and Metalliferous Mines Regulation Acts, fifty-two of which resulted in convictions. In the same year there were 859 prosecutions of workmen for offences under these Acts, 829 convictions being obtained.

Mining Legislation.

The beneficial effect of mining legislation for the prevention of life and limb since 1851 was strikingly shown at the recent annual meeting of the South Staffordshire and East Worcestershire Institute of Mining Engineers. Mr. Isaac Meachem, the newly elected president, traced the circumstances which gave rise to our present elaborate system of inspection and regulation. For the year 1851, the first year of the Act for inspection of coal mines in Great Britain, the proportion of lives lost was 1 in 219; for the year 1855 it was 1 in 254, or a reduction of from 4·55 to 3·93 per thousand, a result which justified the passing of that Act. For the year 1856, the year in which "an Act to Amend the Law of the Inspection of Coal Mines in Great Britain" came into operation, the proportion was 1 in 233, in 1860 it was 1 in 248, or a reduction from 4·12 to 4·02 per thousand. In 1861, when the "Act for the Regulation and Inspection of Mines" came into force, the accidental death-rate was 1 in every 299 persons employed, in 1872 it was 1 in 194, a reduction from 3·34 per thousand to 2·53 per thousand, and this in spite of the fact that during this period several terrible explosions occurred, including one at the Oaks, when 361 lives were lost, and another at Ferndale with 178 lives lost. The total reduction was from 4·55 per thousand in 1851 to 2·53 per thousand in 1872, or 44·4 per cent.

Dealing with the percentage of life saved in 1902 as compared with 1851, Mr. Meachem showed that in 1902 the loss of life was 984. The same percentage of loss for 1902 would be 3,754, a difference of 2,770, which represents the saving of life in 1902 as compared with 1851.

Ankylostomiasis.

The report of Dr. J. S. Haldane, F.R.S., on Ankylostomiasis in the Westphalian Collieries, is now available, and sets forth the means which should be taken for preventing the spread of the disease in Great Britain. During the month a conference was held at the Home Office between the representatives of the coal owners and the miners of England and Wales on this subject, when the following conclusions were reached.

(1) That the time had not yet arrived for the promulgation of special rules; (2) that it is desirable that local conferences should be held in each district between the owners and miners in order to agree upon the best measures to be taken; (3) that a recommendation should be made to the Home Secretary that, in the event of his attention being called to any mines which were seriously suspected of being infected, arrangements should be made for an examination of them; and (4) that the Secretary of State should also be asked to circulate information as to the disease, its diagnosis, treatment, and other particulars, to medical practitioners in mining districts, and also (in a more popular form) to the persons engaged in the mining industry.

Although not a fatal disease in the ordinary sense of the word, Ankylostomiasis is nevertheless a fearful scourge when once it obtains a hold in a mining district, for one of its effects is to deprive the men of energy. A useful pamphlet on this subject has been issued by the *Colliery Guardian*, setting forth the cause, treatment, and prevention of the disease, the characteristics of which have already been discussed in these columns. The subject is very fully dealt with, and the absolute necessity of co-operation between employers and the men in effecting the necessary sanitary precautions, is emphasised. It is mentioned that the earliest recorded discovery of *Ankylostomum duodenale* in Europe was by Dubini in 1838, but it was not until the outbreak of anæmia among the workmen driving the St. Gothard tunnel in 1879 that it was recognised as a dangerous parasite.

It is very satisfactory to know that this matter has been engaging the continuous attention of the Home Secretary since the appearance of the disease in a Cornish mine towards the close of last year, and that everything has been done both by investigation in Cornwall and in Westphalia, to prevent the spread of Ankylostomiasis in this country.

Coal Mining at Home and Abroad.

By the latest Board of Trade returns, the total known coal production of the world, exclusive of brown coal or lignite, is shown to be about 700,000,000 tons (of 2,240 lb.) per annum, of which the United Kingdom produces rather less, and the United States rather more, than one-third.

The following statement shows the production of coal in the five principal coal-producing countries of the world in 1900, 1901, and 1902 :—

	1900.	1901.	1902.
	Tons.	Tons.	Tons.
United Kingdom* ..	225,181,000	219,047,000	227,095,000‡
Germany† ..	109,290,000	108,539,000	107,436,000‡
France† ..	32,722,000	31,634,000	29,574,000‡
Belgium† ..	23,463,000	22,213,000	22,769,000‡
United States*	240,788,000	261,874,000	268,688,000‡

As compared with its population, the production of coal in the United Kingdom still surpasses that in the United States.

The following statement shows the average value per ton of the coal produced taken at the collieries, in the various countries in the year 1901 :—

United Kingdom, 9s. 4¼d. per ton ; Germany, 9s. 4¼d. per ton ; France, 12s. 7½d. per ton ; Belgium, 12s. 2¼d. per ton ; United States, 5s. 6½d. per ton.

These prices represent a fall of about 1s. 6d. per ton in the United Kingdom, and 1s. 9d. per ton in Belgium, but a rise of 6d. per ton in Germany, 7d. per ton in France, and 3d. per ton in the United States.

The provisional figures available for 1902 indicate a further fall of 1s. 1d. per ton in the United Kingdom, whilst in Germany there has been a return to the level of 1900, and in the United States a further rise of 3d. per ton.

In spite of the fall in prices in this country, the average value continues considerably higher than it was before the great rise which took place in 1900.

In the excess of exports over imports the United Kingdom heads the list by exporting 60,400,000 tons, or 36 per cent. of the total output. In the United States 6,127,000 tons were exported, which represents about 2·3 per cent. of that produced.

The total consumption of coal in the United States, amounting to 265,105,000 tons, surpasses that of any other country ; the United Kingdom last year used 166,698,000 tons.

The value of the minerals produced at the mines and quarries of the United Kingdom in 1902 was £107,134,854, a decrease of eight millions compared with the preceding year, mainly owing to the reduced prices paid for coal.

Miners' Wages.

At Cardiff, Lord Peel, in his capacity as Chairman of the South Wales Coal Conciliation Board, has granted the owners' demand for a reduction of 5 per cent. in miners' wages. Submitting the case for the coalowners, Mr. F. W. Davis pointed out that, according to Sir David Dale's award, the average selling price equivalent to a *minimum* wage of 30 per cent. above the standard was fixed at 11s. 10d. An audit of the selling prices for the quarter ended October last showed the average to be 12s. 9d., and wages were 48¾ per cent. above the standard. Thus in respect of the 11d. per ton difference between 11s. 10d. and 12s. 9d. the owners were now paying in wages 18¾ per cent., whereas under the old sliding scale the men were entitled only to payment at the rate of 8¾ per cent. in respect of every shilling advance in the average prices of coal. Mr. W. Abraham, M.P., replying for the men, urged that the owners' figures did not agree with those of the Custom House returns, which showed a higher average selling price, and the owners pointed out that those statistics, being filled in by office boys, were not reliable. Mr. Abraham said the men had offered to compromise on a reduction of 3¾ per cent. At the suggestion of his lordship the owners retired to reconsider this offer, but on their return they declared they could not recede from their demand for 5 per cent. They felt they were entitled to 10 per cent., and it was from a desire to act in a spirit of compromise and conciliation that they limited their demand to 5 per cent. Ultimately his lordship granted the 5 per cent. reduction.

New Zealand Mines.

Notwithstanding the fact that several New Zealand mines have closed down during the last two years, the yield of gold throughout the Colony has increased. The report of the Department of Mines on the goldfields of New Zealand in the year 1902 shows that for the year ending December 31st, 1901, the value of gold entered for exportation was very largely in excess of that of the previous year, while an increase amounting in value to £197,650, is reported for the year ending December 31st, 1902, the total value for the year being £1,951,433. This is the highest yield since 1873, and makes a total value of £61,111,316 for gold exported from the year 1857 to the end of 1902. With regard to minerals other than gold, the report states that some 40 tons of scheelite have been separated during the year by Messrs. Donaldson Bros., of Golden Point, Macrae's, Otago. The mineral occurs in the quartz, and is saved by concentration. Negotiations have been commenced during the year with the object of working the ironsand deposits of Taranaki and the ironstone at Parapara. A discovery of rock phosphate was reported from Clarendon, Otago, in the spring of the year 1902, and since that time developments have progressed rapidly. Deposits of phosphate were found to exist, which, when opened out, proved quite equal to the most sanguine expectations, and from these quarries 2,000 to 3,000 tons have already been mined.

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* Tons of 2,240 lb.
† Metric tons of 2,204 lb.
‡ Provisional figures.

SHIPBUILDING NEWS.

State of Shipbuilding.

As the year draws to an end, work in the shipyards declines. After the little spurt in September, October was dull in the extreme, partly as the result of the collapse on the stock markets and the general financial hesitation, and partly as the result of the expectation of a considerable amount of American "dumping" of steel. Enough is known to show that the tonnage output for the year will be considerably under that of last year. The amount of work on hand in the Scotch yards has declined about 150,000 tons during the year, and the position in the North of England seems even worse. The monthly launches are now about double the amount of new tonnage booked. These facts have so impressed themselves on the minds of the shipyard workers and marine engineers that the agitation for an increase of wages has disappeared, and the movement now is towards a reduction of wages. In the North of England the employers have notified a reduction of 5 per cent. in December. Recent contracts for cargo boats have been placed at very low rates, viz., at £6 to £5 12s. 6d. per ton deadweight capacity for large-sized boats. This is just about the price of steel ship plates, which, however, ought now to become a little cheaper since pig iron has come down. Wages, however, are about 30 per cent, higher than when new ships were being contracted for at anything like present prices. In the early part of November some fair contracts for new ships were placed.

Turbines.

The Cunard Turbine Commission are, in the course of their investigations, to spend some time in New York, conducting experiments with two sorts of turbines which have been patented by prominent marine engineers of that city and vicinity. And, in the meantime, Messrs. J. and A. Allan, Glasgow, are in the market for a second liner for their Canadian service to be fitted with turbines instead of reciprocating engines. This new steamer is to be a sister-ship of the *Victorian*, now building in the yard of Messrs. Workman, Clarke and Co., Ltd., Belfast, but it is not yet settled, while we write, where she will be constructed, offers having been invited from a number of shipbuilders. The new vessels will each be about 540 ft. long overall, of 12,000 tons gross, and 30,000 i.h.p., with a speed of 17 to 18 knots, that is, about two knots faster than the *Bavarian* and the *Tunisian*, which are at present the Company's fastest liners.

Shipping Statistics.

In these days, when statistics are so much in vogue, it is remarkable how fantastic is the employment of figures relative to shipping. In no other department of commerce is it so noticeable. Thus gross and net and registered tonnages, deadweight tonnage, entrances and clearances, repeated voyages and so on are used to bewilder the plain man anxious to know the plain truth. One authority says that the United Kingdom owns 9,152 steamers and sailing vessels of 100 tons and upwards, aggregating 14,889,570 tons-gross of steamers and net of sailers—and another gives the figures as 7,221 and 9,492,327, respectively. It is not explained that the latter tonnage is net, or that the first-named represent the returns up till June 30th, and the latter to December 31st only. Then, again, the figures include wooden and composite vessels, which have little influence on the ocean carrying trade of the world, and are, therefore, of little statistical value. These points acquire considerable interest when one considers the vastly predominant mercantile marine of Great Britain compared with other maritime countries, from a foreign trading point of view. A contributor to the *Glasgow Herald* has prepared the following special table, ignoring all wooden and composite vessels. An attempt was made to obtain the figures for sailing vessels of 800 tons and upwards, and for steamers of 1,000 tons and upwards—these being limits practical towards an estimate of the actual ocean-going tonnage having influence on the freight market. The figures of foreign countries could not be readily obtained, however, and the minimum of 100 tons had to be taken. This limit includes a large number of craft whose commercial career is extremely restricted in its area of operation :—

The World's Iron and Steel Tonnage.

	Steam Gross tons.	Sail. Net tons	Total tons.
Britain and Colonies	14,088,729	1,426,415	15,515,144
America (ocean) ..	1,039,367	109,683	1,149,050
Denmark	481,976	35,769	517,745
France	1,151,166	402,128	1,553,294
Germany	2,793,621	442,187	3,235,808
Holland	611,997	32,529	644,526
Italy	703,386	188,028	891,414
Japan	515,860	—	515,860
Norway	891,322	205,631	1,096,953
Russia	573,642	41,943	615,585
Spain	719,286	3,012	722,298
Sweden	477,042	24,628	501,670
All others	1,670,985	56,647	1,727,632

Shipbuilding News.

Ocean Tonnage.

The shipping tonnage owned by the United Kingdom and her Colonies and dependencies is thus shown to be 15,515,144 tons, gross of steamers and net of sailers. The tonnage owned by the whole of the rest of the world, according to Lloyd's Register, amounts, to 13,171,835 tons on same basis. But the tonnage owned by the United States in coasting and special trades has practically no influence on the freight markets of the world, and may be deducted. This brings the world's ocean tonnage down to 12,022,785 tons, against our 15½ millions. If the tonnage owned by British Colonies and dependencies be deducted, we get 14¾ millions tons for the United Kingdom, against slightly over 12 millions for our real competitors. Japan has no sailers entitled to take a place in this table, and the average size of her steam fleet is the highest of any country. Germany, Italy, Great Britain, and Holland follow next, in the order named. In average size of sailing vessel France is first, the next in order being Great Britain, Germany, Italy, and Russia. What is called the "world's tonnage" will have to be increased by 22 per cent. before it equals that of this country. Last year we added a greater tonnage to our fleet than France, Germany, Italy, Norway, and Sweden combined and that in spite of sailing and building bounties.

Oil Fuel for Steamers.

The Admiralty Committee on Oil Fuel have witnessed an important series of practical tests at the works of the Wallsend Slipway and Engineering Company, who have fitted many vessels in recent years with the system. The boiler used was of the ordinary marine type, 12 ft. 6 in. in diameter, and 11 ft. long, with 262 tubes of 2½-in. external diameter, and fitted internally with retarders. The total heating surface was 1,695 square feet, and the grate area 40 square feet. There was, first, a trial of coal, when the rate of consumption was 24·3 lb. per square foot of grate, and each pound gave 9·31 lb. of steam from and at 212° F. Texas oil was then tried under natural draught, and the consumption of the oil was equivalent to 15·8 lb. per square foot of grate, each pound of oil giving 14·45 lb. of steam from and at 212° F. On a trial with closed stokehold the air pressure was increased to 1⅛ in., and the quantity of oil burned was almost doubled, 30·5 lb., while the evaporative efficiency was about the same, 14·06 lb. By the use of 1⅛-in. pressure it became possible to practically double the steam supply. The system of burning the fuel is that of Rusden and Eccles, of which the Wallsend Company are the sole manufacturers. This system has been very successful, but is open to the objection that the steam used in spraying the fuel is lost, and the boiler feed-water has to be made up on board ship by the use of large and expensive evaporating plant. The method of burning liquid fuel successfully demonstrated to the Admiralty is that known as the Korting system, in which the oil is forcibly sprayed direct into the furnace through a Korting sprayer by means of a pump. The use of a steam jet is entirely obviated, and with the Korting burner no additional evaporative plant is necessary. The boiler at work was completely enclosed in an airtight house, so as to show the system working under both natural and forced draught conditions. The burners were first worked under natural draught, and the stokehold was then closed and the fan started, when it was demonstrated that the system can be worked with almost any degree of air pressure. Starting with a very low pressure, it was increased until 4½ in. was recorded on the gauge. Throughout the trial no smoke was visible at the chimney, which implied that combustion was perfect.

A Record Liner.

On the 21st of the month there was successfully launched at Belfast the steamship *Baltic*, this being the fourth of the series of vessels built by Messrs. Harland and Wolff for the White Star Line since 1899. The vessel has the distinction of being the largest afloat. She exceeds the *Cedric* by some 3,000 tons, her capacity for cargo will be 28,000 tons, and the displacement at her load draft about 40,000 tons. The dimensions of the ship are as follows: Length, 725 ft. 9 in.; depth, 49 ft.; breadth, 75 ft. There will be accommodation in all for nearly 3,000 passengers. The *Baltic* will be fitted with engines of Harland and Wolff's quadruple expansion type, about 13,000 indicated horse power, and the speed will be about 16½ to 17 knots.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

Wide Range Speed Control of Motors.

The speed of a motor depends on the two factors of impressed voltage and the value of the magnetic line density in the armature core. The most common methods of altering the speed are first to insert resistance in the armature circuit, thereby cutting down the impressed voltage, and second, by a resistance in the shunt circuit, thus reducing the magnetic flux. Speed variation obtainable by these methods is, however, limited for the reasons of economy and expense, and also that if the magnetic flux is reduced too low, sparking will result.

For wide range control the methods best known are—building the motor with two commutators for connection in series or parallel, and the Ward Leonard, the Westinghouse, and the Bullock systems of using an auxiliary motor generator to provide widely varying voltages. These methods have been employed successfully for operating printing machines, calenders, etc., which it is necessary to "crawl" round when starting. They are expensive and complicated, so much so, indeed, that probably a second small auxiliary motor for running the machines slowly would prove as good a solution. (It is in fact, adopted where such machines are driven by three-phase motors.)

There is one method of altering the speed of a direct current motor which is *purely mechanical*, and which the writer believes has been suggested at various times, but for some unknown reason never acted upon. It is to make the central portion of each pole piece of the motor moveable, so that the air gap can be lengthened and the magnetic flux reduced as may be desired. To secure sparkless commutation the pole tips must be fixed so that as the central portion of the pole is withdrawn the magnetic flux will concentrate more and more into the pole tips, and so give a magnetic fringe of sufficient intensity.

It will be readily seen that by means of screws actuated by bevel gear it would be possible to actuate all the moveable portions of the poles together, and with very great nicety from a single hand wheel, and it is interesting to note that the Stow Manufacturing Company, of Binghampton, U.S.A., are bringing out a motor on these lines.

The Extreme Simplicity of the Multiphase Motor.

A well-known electrical engineer has stated that, in his opinion, if continuous and alternating current machines were starting level to-day, that the chances of the former would be small. The air of mystery about alternating current apparatus is really very stupid, because continuous current machines are far more mysterious and difficult to design. Every continuous current machine is in fact a *bad alternating* machine with a knotty problem—the commutator—tacked on to it.

The extraordinary simplicity of alternating current was impressed on the writer's notice recently at the Railway Foundry, Reading. Men who had been accustomed all their lives to ordinary rough mechanical work, general repairs, etc., were turning out two and three-phase motors equal to any made by electrical firms. There were no testing facilities, and yet all the motors supplied had worked perfectly. Of course, it goes without saying that the drawings and windings were standard sizes (which had been developed and tried elsewhere) supplied by an outside electrical expert. This method of turning out electrical machinery is likely to become popular as soon as mechanical engineers see that it is not necessary to engage highly paid assistance.

The Advantages of Standard Motor Speeds.

Besides its extreme simplicity, the multiphase motor, especially when it is of the short circuited type, has the very great advantage that by sheer force of circumstances it may be said to have standardised itself. Every manufacturer of such motor makes them of certain standard horse-powers, 5, 7, 10, 15 h.p., etc , and what is more important, *to standard speeds*, The speed is dependent solely on the periodicity and this latter being almost universal at 50 cycles per second, has been the means of bringing about this most desirable feature. The mere fact that the continuous current can be designed to run at practically any speed is against it, for it is at the mercy of any consulting engineer, who thinks he can design, or the callow technical student, who certainly can not. Then there are the variations in quality of steel and copper and slight differences in size. In a multiphase motor, given a certain number of poles and the standard periodicity, the machine *must run* at synchronous speed less the small 3 or 5 per cent. of slip. It is practically independent of slight variations of material and size, etc., so far as speed is concerned. It is a distinct advantage to the customer to know that wherever he buys the motor the speed will be the same, because he can thus make all his arrangements for the gearing or belt drive independently of the motor.

Vibration of Electric Motor Drives.

Where a motor has to drive through spur gearing there is sometimes vibration due to the teeth not running sweetly, and if the armature conductors consists of round wire it may happen that in time they manage to hammer a depression in the micanite troughing. One way to prevent this is to use flat copper strip instead of round wire, as it then presents a flat surface of considerable area to the micanite. Another way to help matters is to back up the micanite troughing with a layer of press-sphan and so provide a springy bed between the micanite and the iron.

Of course gearing has no business to cause vibration, especially if it has cut teeth. Unfortunately, however, it often happens that the wheel and pinion are ordered from two separate firms without any care being taken to see that the teeth are set out to the same rolling pitch circle. Raw hide pinions have done much to give easy noiseless running for motor drives, and worm gearing also has much to recommend it. In fact. to use an Irishism, there are so many cures for vibration troubles. that they have no business to exist.

Early Dynamo History.

It is instructive to look through an early edition of Dr. Thompson's "Dynamo Electric Machinery," or similar publication, and compare the various ingenious designs therein illustrated, with the simple piece of apparatus which the dynamo has developed into to-day. Consider for a moment the ingenuity of the Eickemeyer armature and field winding, and compare it with the simple barrel winding and the plain field spools of a modern machine. Or take the Brush and Thomson-Houston dynamos, the latter with its heroic pneumatic arc blow-out, and compare with a modern high tension machine. What weird and wonderful and extremely inefficient machines those old arc lighters were. How very handy the trailing horns of the pole pieces used to be, for warming coffee, until Mordey came along with the idea for laminating the armatures. Then the infamous Desrosier dynamo—which was to do away with iron in the armature—what a mechanical absurdity it was to be sure. And so on, to the commonplace two-pole machine with fibre pegs and go-as-you-please drum winding which, to the Electrical Profession's discredit, still survives.

Then consider for a moment the stages through which the alternator has passed, and the fights which used to rage over the coreless and ironclad machines. How ridiculously wanting, when considered as a piece of mechanical design, those early alternating machines were. The only conclusion the engineer of to-day can come to, is that if the early workers in dynamo machine design had been as good mechanical engineers as they were inventors, it would have been better for them and the profession generally.

They were as wanting as those early makers of safety bicycles, who employed the diamond frame and had not the engineering gumption to put a bar across and turn a redundant frame into a rigid one, yet they could have learnt this from any old fashioned millwright, or by a few minutes' study of a five barred gate. So it was with the early school of dynamo designers, until properly trained engineers like Brown came along, and the dynamo began to take shapely lines and become an Engineer's rather than an Electrician's job.

The Simplest Designs Must Persist.

Yet, it must not be forgotten that all the early workers, from the pure shellac-and-rubbed-amber-man of prehistoric times, through the various stages of promoted telegraph operators and wiremen, and the inventive professor of physics, etc., have done something towards bringing the dynamo machine to its present satisfactory state as a piece of machine design. There are also one or two things the early dynamo designer can claim to have introduced. The self-oiling bearing, for example, although first used for line shafting, has been developed and made widely known as a distinctive feature of the dynamo machine. Dynamo making also brought into the market various materials such as micanite, which will have an increasing sphere of usefulness in the future, and steel makers were spurred to investigate the magnetic qualities of their manufactures, whether for magnets or laminated sheets by the never ending cry for efficiency.

Younger men who are entering into this rich inheritance—the Electrical Engineering Profession—who have been taught the theory of redundant and rigid framing, and the limitations of the various materials by *actual test and experiment*, must not judge early workers too critically. The technical schools and colleges of those days were few and far between, and fees high. The writer is not at all sure even now, that the higher technical education available has altogether squashed the tendency to complication and intricacy of design. The best lesson a young engineer can learn is to always plump for simplicity. In every form of mechanism the simple type must persist, however ordinary looking and uninteresting it may be.

The Self-Oiling Bearing.

The idea of the self-oiling bearings appears to have been first published in *Engineering* in 1867, but it had to wait twenty years until dynamo making became established before it had any extensive application, and now the *loose ring* oiler is almost universal.

The self-oiling bearing is one of those little mechanical devices which the dynamo machine has helped to develop and make widely known. As it is likely to become universal for all types of bearings, even for engines and machine tools, a few notes on its early introduction into this country may be of interest.

The writer first saw a bearing of this character in 1892, in the old Lambeth Works of the Brush Company. The bearings were imported from abroad, andsaid to have been the invention of Professor Mohler. They were employed for supporting line shafting, and worked so well that it was decided to try them on dynamos. They were accordingly adopted on the first Brush Falcon machine which the writer designed for the company, and this was probably the first dynamo machine to have self-oiling bearings in this country.

As the ring in the Mohler bearing was fixed to the shaft, and of comparatively small diameter, it could not dip very far into the reservoir. In order to overcome this, both chains and loose rings were tried, and as the chain raised most oil, it was adopted on all the early Brush machines. They were of a special kind which could be disconnected at every link by simply turning it at right angles. This simple self-oiling device has undoubtedly played a leading part in enabling the dynamo machine, and particularly the electric motor to attain the position it does to-day as a piece of reliable mechanism requiring a minimum of attention.

IRON AND STEEL NOTES.

The Importance of Proper Hardening.

In *The American Steel Worker** Mr. E. R. Markham has compressed twenty-five years' experience in the selection, annealing working, hardening and tempering of various kinds and grades of steel. An early opportunity is taken of emphasising the extreme importance of proper hardening. The writer's experience has convinced him that few mechanics realise the vast waste of time in many shops because tools are not capable of doing the amount of work possible were they properly hardened. Take, for instance, a milling machine cutter which runs at a periphery speed of thirty-six feet per minute, milling a mild grade of machinery steel. It is found necessary to stop this machine once in twenty working hours to sharpen the cutter, milling in the meantime five hundred pieces. A cutter is made from the same bar, and hardened by a process that makes it possible to run the tool at a periphery speed of eighty feet per minute, and it is then found necessary to grind but once in two hundred hours; milling in the meantime eight thousand pieces. Not only is the efficiency of this machine increased manyfold, but the expense of grinding and the necessary delay incident to stopping the machine, changing cutters and setting up, and the cost of tools per piece, is reduced very appreciably.

A study of the nature of steel will convince one of the importance of extreme carefulness when heating either for forging, annealing or hardening. A man who understands the effect of heat on high carbon tool steel is often amazed at the careless manner which many old blacksmiths assume when heating a piece of steel. A difference of one hundred to two hundred degrees of heat after the steel is red hot, does not, according to their idea, injure the steel in the least, but in reality it makes a vast amount of difference in the strength of the piece.

It is an acknowledged fact, says Mr. Markham, that the lowest possible heat at which steel will harden leaves it the strongest.

Steel for Various Tools.

No topic connected with his work caused the writer so much anxiety, as the question of the steel to be used for various tools. A temper of steel that gives entire satisfaction when used in one shop would not answer when made into tools intended for the same or similar purposes in a shop situated on the opposite side of the street. This is simply because in one case the operator who forged or hardened the tools understood handling the steel, and in the other case a man totally incompetent was entrusted to do the work

Then, again, steels of certain makes are more free from harmful impurities than others. A steel containing a low percentage of these impurities can safely have a higher percentage of carbon. Certain steels which are low in their percentage of phosphorus can have a greater amount of carbon than other steels which contain more of this harmful impurity. A tool made of 1·4 per cent. carbon steel low in phosphorus will not cause as much trouble as if made of a 1·25 per cent. carbon steel containing a greater amount of phosphorus, but its capacity for cutting hard metals, and holding its edge when running at high speeds, is much greater.

Knowing the tendency in many shops to use a high carbon steel and realising the advantages of so doing, the author says he would advocate the use of such steel, were it not that in many cases the results have been anything but satisfactory, because men totally unfit for such work were employed to forge and harden the tools made from them.

The tempers of tool steel suited for certain purposes are given, but the reader is asked to bear in mind that in many cases it is safe and advisable to use a higher carbon, provided due care is exercised when working it during the various operations of forging, annealing and hardening. As previously stated, steel of a certain make and temper giving excellent results in one shop does not always give satisfactory results in some other shop on the same class of work. Knowing from experience that the variable factor is the man working the steel, rather than the steel itself, the author has deemed it wise to quote the experience of various steel makers, rather than results of his own personal experience :—

Tempers of Steel.

Degree of Hardness.	Per centage of Carbon.	Should be used for
Very hard ..	1·5	Turning and planing tools for hard metals, small drills, gravers
Hard	1·25	Tools for ordinary turning and planing, rock drills, mill picks, scrapers, etc.
Medium hard ..	1·	Taps, screw thread dies, broaches, and various tools for blacksmiths' use
Tenaciously hard	·85	Cold sets, hand chisels, reamers, dies, drills
Tough	·75	Battering tools, cold-sets, shear blades, drifts, hammers, etc.
Soft	·65	Battering tools tools of dull edge, weld steel for steeling finer tools, etc.

While the foregoing table gives the tempers of steel that can safely be used for the purpose specified, it is many times advisable to use steel of a higher percentage of carbon.

Necessity for Cheap Coal.

In addition to his remarks on the fiscal question, Mr. A. Lamberton, in his presidential address to the West of Scotland Iron and Steel Institute, touched upon a number of other topics of considerable interest in the iron and steel world.

They had heard from many sources the warning that their supply of coal was showing signs of exhaustion; and as this lay at the very foundation of their national prosperity, the question must be seriously faced in the near future. The very existence of the iron and steel industry depended upon their getting cheap coal; and if the upper seams were showing signs of early exhaustion, it was evident that they must be prepared with competent methods to go down to the deeper levels at which other seams are known to exist. This necessity would bring with it many problems for solution. The temperatures at a depth of 4,000 ft., at which some of these seams lay, reached the high point of 130° F. Manual labour in such a temperature was therefore practically barred; and the ventilating of these deep levels must be done in such a manner as to obtain temperatures that would admit of the work being conducted successfully. The introduction of electricity in mining had of late years been steadily on the increase, and seems to point to the possibility of these deep seams being successfully dealt with by this most useful form of power. The adoption also of machinery for coal-cutting was gradually becoming more universal. A commission sat lately for the purpose of investigating the economies to be secured by coal-cutting by machinery; and, without going into the details, he might state that it showed a very substantial economy by this system of coal-cutting. It was evident, therefore, that in future the introduction of machinery for coal-cutting must be greatly extended and in deep mines the adoption of electricity for ventilating, hauling, pumping, and coal-cutting might render it possible in future to raise their fuel supplies from these deep levels at a cost that would compare favourably with present costs where these appliances did not obtain. Very likely that might mean that the day of the small coal-owner was past, and that the working of these deep seams would be done by firms and companies possessed of large capital, who could afford to spend large sums in the way of complete and most modern equipment to attain the end in view.

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* "The American Steel Worker," by E. R. Markham. The Perry Collard Co., New York.

Transport.

There was also the important consideration of their ore supplies. For purposes of mild-steel manufacture their hematite ores were to a very large extent imported; and the cost of mining and transit by sea and rail to the works here seemed to leave very considerable room for reduction in the future. In America they built special steamers for carrying ore, and they built special docks for loading and discharging these vessels with every modern mechanical appliance for reducing labour, and in railway transit they had led the way in building wagons of large carrying capacity. Were they justified in regarding the competition which they were experiencing at the hands of these other nations as unfair when they had done practically nothing on the lines which he had described, with the view of cheapening and winning and carrying of these foreign ores to their shores? He was glad to think that they were doing something. Their railway companies had now become conscious of the necessity for special wagons being built for special traffic, and now there were quite a number of steel-framed coal and ore-carrying wagons capable of taking 40-ton loads. He trusted that when the benefit of the use of these wagons was felt, the system would be more largely developed in the future, and that the economies resulting therefrom might advantageously affect railway rates.

Blast-Furnace Practice.

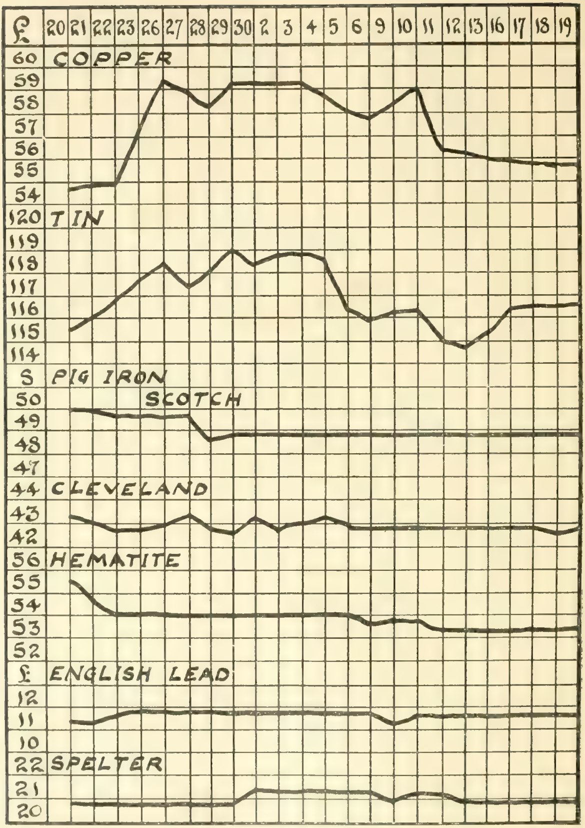
Within the last year or two great attention had been directed towards the blast-furnace practice of this country. The wonderful reports that they were constantly hearing as to the enormous outputs from furnaces in the United States, naturally directed attention of the owners of furnaces here towards this subject. So great was the disparity between the outputs obtained from their furnaces, compared with those of America, that the belief came to be held by some that their blast-furnace practice was all wrong, and that if they wanted to make iron economically, they must follow America in the building of large furnaces, and in the adoption of the high-blast pressures obtaining there. He was by no means sure, however, that such conclusions were reached, as they should have been reached, only after the most exhaustive inquiry. The conditions prevailing in America were undoubtedly different from those obtaining here. Much of their ore came to their furnaces in small granular form, which when charged into high furnaces, of necessity packs closely in the zone of the tuyeres, and necessitates the adoption of a high-blast pressure.

American Methods.

The blast pressure which is used in this country, with their more open ores, was quite inadequate to deal with that fine granular ore, and hence in America they adopted pressures up to 20 lb. per square inch, as against their 10 lb. per square inch. So far as he was aware, the reconstructions which had been carried out in this country with a view to working their furnaces on the American principle of high-burden and high-pressures, had not been a success financially. On the contrary, he was informed that their ores could be smelted in their own type of furnaces, and with their more moderate blast pressure, at less cost per ton, than by the American system of high-pressure working, and it was not without interest to learn that one of their most important iron and steel companies, who had entered into negotiations with American engineers for re-construction of their blast-furnace plant, had cancelled the contract pending further investigation. There did not seem therefore to be conclusive evidence that their best present blast-furnace practice had been so far wrong, when they considered the nature of their fuels and ores, and it was questionable if they would see higher pressures than 10 lb. per square inch used to any extent in this country at least for some time to come.

Mr. Lamberton also remarked that, when on the subject of blast-furnaces, it was difficult to resist expressing the conviction that in the future this would be found to be an essential part of a modern steel works. Whether he was right in saying that the blast-furnaces should be part of the steel works, or that the steel works should be an adjunct to the blast-furnaces, was a matter that need not be discussed, but the great economy that could be effected by charging Siemens' furnaces with molten iron was so important that as competition became keener it would render this combined system an absolute necessity.

The address which Mr. F. H. Marshall delivered at the annual meeting of the Cleveland Institution of Engineers, held at Middlesbrough, also contained a note of warning against the slavish copying of American methods before making quite sure that they are best suited to English requirements.



THE HOME METAL MARKET.

Chart showing daily fluctuations between October 20th and November 19th

POWER STATION NOTES.

Steam Boilers in Tiers.

With the rapid increase in the size of central power stations, a curious feature has developed in connection with the boilers. It is that the sizes of boiler units have not kept pace with engine and dynamo units, the consequence being that relatively much more room is required for the boiler plant. This is especially emphasised when turbo-electric generators are employed, as, for example, in the Chelsea Power Station now being erected for the Underground Railway. The turbo generators give 8,000 h.p. each, whereas the boilers are only about 500 h.p. As a result, there are no less than 64 Babcock and Wilcox boilers to work the five turbo-electric generators, and in order to find room for all these boilers, the American plan of placing them on floors, one above the other, has been introduced. In this difficulty *re* the boilers, the writer sees another telling argument in favour of gas-engine plant. The gas engine (possibly the gas turbine) seems bound to come out on top.

Vacuum Cleaning for Central Station Machinery.

Everyone who has had to run large electrical generators knows the difficulty there is in dealing with dust embryo cobwebs, etc., and this is especially the case in high tension stations. Dusting in the ordinary way is no use, as it is too long a job, besides it simply flicks about the misplaced matter, and does not remove it. Sometimes a small motor-driven air compressor is employed to clean the alternator and dynamo or switchboard by blowing air on to the apparatus, but this has the same objection. It has occurred to the writer, however, that the new vacuum-cleaning system is just the very thing for the work, as it removes the dust, etc., right away, and does not merely blow it into some other place in the station.

Central Station Balancers.

When the three-wire system was first introduced, it was customary to have central station dynamos arranged on each side of the middle wire. Then came the idea of having larger units connected direct across the outers, and in order that the out of balance current might be looked after, the balancer was introduced. The fashion having been set, as it were, everybody thought it the right thing to have a balancer in their station, whether it was really necessary or not. As a matter of fact, it is just a question whether it is not best to have double dynamos or double commutator machines throughout, and dispense with these balancers, as they are rather wasteful pieces of machinery and somewhat flimsy. Before everything else, central station machinery must be reliable and simple. If a short comes on to a circuit connected with large machines, the chances are that the machines will burn it out and keep going, but if a small and somewhat flimsy balancer is in circuit the latter suffers.

The Importance of Condensing with the Steam Turbine.

The application by Parsons of a condenser to the steam turbine was a very important improvement, because it enabled those low-steam consumption tests to be made by Professor Ewing which so astonished the engineering world. It is not generally recognised, but in applying a condenser to a steam engine, high degrees of expansion require very large cylinders, and, in fact, increase the size and weight of parts beyond all practical limits. This will readily be seen from the fact that as the condenser approaches a *perfect* vacuum the volume increases at a rapid rate, thus the volume of steam with a 29-in. vacuum *is double* that with 28 in. A very high vacuum is unattainable in the ordinary steam engine because of the leakage of air past the piston rod, etc., and in any case the increased vacuum has little effect on the steam consumption with cylinders of usual proportions.

Now in the case of a steam turbine the position is quite different, because by simply increasing the diameter of the rings and the spaces between blades, the highest degrees of steam expansion are easily provided for. Further, owing to there being no piston and rod, valves, etc., leakage of air into the condenser is almost impossible, and a much higher vacuum is therefore attainable. Again, as no oil comes in contact with the steam the condensed water can be used in the boilers, and this reacts in improving the vacuum, the water not being aerified.

Points on Condensers.

In order to get the full value out of a condenser there are several points which should be borne in mind. The first is that it should be as near to the engine as possible, and obviously the best way of doing this is to have a separate condenser to each unit. It is a great advantage also to have each unit self-contained, so that there are no separate little independent pumps to start up simultaneously with the main engine. When an independent condenser is employed it should be situated in as central a position as possible in the engine room in order to shorten the piping as much as possible.

Owing to the nature of the service, spare condensing plant is very seldom installed, because if anything goes wrong the engines can be temporarily run *non*-condensing. It must be remembered, however, that this means practically overloading the engines by nearly 25 per cent., assuming they have been previously working at full power. Some engineers do not seem to mind what vacuum they get, it may be 20 in. instead of 28 in. Clearly, however, if it is worth while going to the expense at all it may as well be done properly, and, as a matter of fact, all it means is ample cooling surface, a good air pump, and plenty of water. Six inches difference in vacuum means about 3 lb. added to the mean pressure, so if we assume 20 in. of vacuum gives 20 lb. mean pressure in any particular cylinder, then by merely taking a little trouble to improve the vacuum to 26 in. the mean pressure goes up to 23 lb., giving an increase in the power of the engine of 15 per cent.

One point to watch in laying down condensers is that the whole system of suction and delivery pipes and the pump should form a syphon so that the work on the pump shall only be that required to overcome the frictional resistance. To ensure this at all times the ends of both suction and delivery pipes must be carried well below the normal surface of the river or canal from which the cooling water is drawn. In English surface-condensers the tubes are usually ¾ in., and for good clean water this is ample. Where the water is dirty or likely to have leaves in it when in spate, then it is much better to have the condenser fitted with 1-in. tubes, this extra ¼ in. makes a big difference. Of course the condenser is larger and more expensive, but it is better to pay a little more in the first instance than to be constantly cleaning out tubes.

When sending condensing plant abroad the climate to which it is going must be taken into consideration.

Errata.—The words "condensing" and "non-condensing" in Table of Steam Turbine Tests, on p. 461 of our November issue, should read "superheated" and "saturated" steam.

AMERICAN RÉSUMÉ.

NEW YORK, November 21st, 1903.

A "Three-Cornered Muddle."

The fact that the United States Government has recognised a new competitor in awarding contracts for armour plate, has given rise to a good deal of heart-burning. *Machinery* remarks that the three-cornered muddle over the contracts to be let for the new battleships, in which the Bethlehem, Carnegie and Midvale steel companies are participating, promises to introduce a new point in law that is of considerable interest to manufacturers. The Bethlehem and Carnegie companies both have large and complete plants for producing armour plate by the Krupp process, and these two companies claim to control the rights for the use of this process in the United States, and exact a royalty from the Government on the plate made at Government plants. The Midvale company have not yet completed their plant for the manufacture of armour plate, and it is not known what process they intend to use; but it is surmised that it will be the Krupp process, also. The Bethlehem and Carnegie companies not only claim that the Midvale company will not be able to complete its contract, if it secures it, within the time specified, but further assert that they will compel the Government to pay royalties on all the plate furnished by the Midvale company, inasmuch as it will infringe on the rights to the Krupp process, which the former concerns control. The peculiar part of the situation is, however, that there is no patent on the Krupp process, and that proprietary rights with regard to it are held solely in virtue of its being a secret process and one that has been developed at great cost and has required the establishment of immense plants for its production. Will the courts decide that there is property in a secret process, even after it has been discovered by other persons and put to use by them? Apparently there is a new point of law involved which it has heretofore been supposed did not exist—and probably would not exist except for the millions of vested interests involved in the equipment of the plants. It remains for the courts to say, however, that this makes the tenure of the process itself any the more secure.

English and American Machinery.

A correspondent of "The Iron Age" has been giving its readers a review of the prospects which await the mechanical engineer in South Africa. Incidentally, a very interesting comparison is made between English and American machinery. "One could hardly say that the greater percentage of machinery used on the Johannesburg mines is of American manufacture, but if he considers that furnished by a certain London company, whose parent company is American, as being American in design though built in England, possibly America could claim the majority.

"It is safe to assume, however, that English-built machinery is holding its own and likely to, except on certain groups of mines controlled by German capital, where naturally German products will be used. The writer has observed that the older engines, both English and American, still running lack the weight and stability to meet present requirements, features that are now insisted on and admissible, due to railroad transportation that was lacking in the early days. The purchasing engineers draw up rigid specifications, which call for first-class workmanship, material and designs that will admit of the heaviest duty in running from week's end to week's end. While they buy on a competitive basis, the engines are taken on their merits rather than on the lowest price. Americans should bear this in mind, as the present impression, founded on fact, unfortunately, (*sic*) is that English machinery is better built. But few mines are equipped with duplicate plants, and breakdowns are not only serious but expensive, and managers are not apt to forget the make of machinery that gives them trouble in this respect.

"In the repair shops of the mines American machine tools are much in evidence, but not in the majority; still, the best equipped shop at one of the largest mines I observed was entirely American, even to standard practice of gauges and tools in the tool room."

Outlook for English Machine Tools.

"It appears that substantial and simple machines are preferred, without numerous attachments for quick changes or repetition work that are never called for in repair shops, since the mines do not attempt to manufacture at present high price of labour, when articles can be purchased in the market. The English tools are considered heavy and reliable, and are likely to grow in favour, while the American is given credit for being handy and quick for light work.

"The English heavy gap lathe is a popular and serviceable machine in these repair shops, and it is claimed a similar American tool has not been produced to give as satisfactory results."

It is remarked that the inefficient American method of packing for export and rough handling continues to be a live topic among engineers in South Africa.

The State of American Shipping.

Desiring to secure opinions on the most suitable methods for "restoring American prestige" on the high seas, *Marine Engineering* has been sounding the opinions of men prominent in the shipping and shipbuilding industries of the United States. The present condition of affairs is summed up as follows:—

The value of American total foreign commerce for 1902 was two and one-third billion dollars; of the tonnage which was engaged in transporting this, only 873,000 tons, or 8·8 per cent., flew the American flag. American coastwise commerce has in the meantime increased, until now the registered tonnage amounts to nearly five million gross tons. In comparison with these two figures—one of the foreign commerce, unprotected, but with an immense field to draw upon; the other of American coastwise trade, which, through the wise provision of the law, is restricted only to American-built vessels—is, indeed, a most striking comment on the efficacy of the two systems.

To regain a trade after it is once lost is indeed a much more difficult problem than to retain one already secured; and, although America at one time transported over 90 per cent. of her foreign commerce, especially favourable conditions must arise before she can in any way regain her prestige. Last year the foreign tonnage actually decreased six thousand tons, and not a deep-sea ship has been ordered for two years. With shipyards closing along the coast because of lack of work, and the few remaining American vessels being displaced in the carrying trade, it takes no argument to convince one of the alarming conditions that confront America.

Stress is naturally laid upon the subsidising of foreign ships, the most recent and conspicuous example quoted being an agreement between the British Government and the Cunard Line. "It is," says *Marine Engineering*, "against these highly-favoured lines under Government patronage that our vessels must complete. In the first place, our ships cost more, the wages paid to all of the crew are much higher than those for foreign vessels, and the food and accommodations for the crew must be better. In the face of these conditions can it be expected that our ships can enter in the foreign trade? The greater wonder is that there is still a vestige of American ships left."

The enquiries have resulted in a preponderance of opinion in favour of discriminating duties. These, it is remarked, "seem to present less difficulties in the path of legislation, and, are more just than the subsidy system, which is possible of being operated in a partisan method. A reduction of, say, 10 per cent. of the duties on goods imported in American bottoms would provide the necessary stimulus and protection to start up shipbuilding. Under this system our foreign tonnage was rapidly built up, and we quickly assumed a leading position as a maritime nation: return to this system should produce similar results"

Radical Changes wanted in United States Navy Yards.

The new Engineer-in-Chief of the United States Navy—Rear-Admiral Rae—distinguished himself in a marked manner in the war with Spain, and has throughout his career shown all the characteristics of a clever organiser. His first annual report, which has just been forwarded to the Secretary of the Navy, is suggestive of radical changes, and is likely to create a good deal of discussion. Urgent recommendations are made for increasing the efficiency of the navy yards, some of which, in the light of Rear-Admiral Rae's searching investigations, cut a somewhat sorry figure: —

Although it has been reported year after year that the facilities for steam-engineering work at the Portsmouth (U.S.A.) yard are totally inadequate, causing delay in the repair and fitting out of vessels, appropriations have been made only for rebuilding the machine shops for an administration building and for a power house and chimney, notwithstanding the iron foundry has been condemned by survey, the blacksmith shop is old, dilapidated and badly located, the boiler shop is a mere shell of corrugated iron with a rotten wooden frame, the coppersmith shop is too small, and the pattern shop is located on the fourth floor of another building. Every steam-engineering building in this yard was built before such appliances as travelling cranes were invented, and they are dark, badly arranged and incapable of improvement. Some of them are already dangerously overloaded, and though additional tools are required there is no floor space for them. Request has been made on the Bureau of Yards and Docks to include estimated cost of an entire set of buildings for this bureau, according to plan submitted in its estimates, and it is hoped that their construction will be authorised. Not only new buildings but new tools as well are required for the proper equipment of this yard, and though an appropriation has been asked year after year none has been granted, though at least $150,000 will be required for the purpose.

Liquid Fuel.

A bright feature of the report is the section which deals with the work of the special Board appointed to make tests of liquid fuel. Their report is expected early in 1904. Admiral Rae considers that when published it will be of inestimable benefit to the manufacturing, maritime and naval world, and will show the far-reaching benefit of careful, conscientious and extended experimental investigation. The demand for the preliminary report of the Liquid Fuel Board and the extended and favourable notice of the work of the bureau in the investigation of the liquid fuel problem clearly shows how appreciative the country at large is of scientific investigation conducted under Government auspices. Tests were not only made with the Texas and California products, but practically every form of burner illustrating a distinct design or principle was experimented with. It is only by reason of the fact that there were urgent demands for the services of the members of the Liquid Fuel Board, as well as for the service of the torpedo boat "Rodgers," that had been kindly placed at the disposal of the bureau by the Bureau of Navigation, that the tests were discontinued. Neither in extent nor in character have these tests been equalled, either at home or abroad, and the bureau feels assured that when the results of the experiments are made known the necessity and advisability of conducting extended investigation in other directions will be made manifest.

The need for the extension and improvement of American Navy Yards is also emphasised in the report of Admiral M. T. Endicott, Chief of the Bureau of Yards and Docks, who mentions that the construction work undertaken by the Bureau has been delayed owing to the difficulty in obtaining structural steel.

The late Dr. Thurston.

America has lost a very prominent member of the engineering profession by the death of Dr. R. H. Thurston, Director of Sibley College of Mechanical Engineering, Cornell University. His reputation as an engineer and teacher was early established by his work as professor of mechanical engineering at the Stevens Institute of Technology, and it has, of course, been accentuated by his many successes at Sibley. In 1886 there were only eight graduates from the college; in 1903 there were 120; and the total registration in Sibley College has increased from about 60, in 1886, to nearly 1,000 at the present date. This growth has been necessarily accompanied with a corresponding growth in the *personnel* of the faculty and teachers, and in the material equipment of the college.

Besides his other activities, says *The Engineering News*, Dr. Thurston acquired some reptuation as an inventor, chiefly in connection with his work in original investigations. His oil-testing machines and his torsion testing machines are most familiar to engineers; but he also made inventions in magnesium-burning lamps, signal apparatus for the army and navy, various machines for testing the properties of iron and other metals and for ascertaining the properties of lubricants; and in addition to this work he made improvements in steam engines and in existing scientific apparatus. He performed much original work in scientific investigation in connection with engineering problems, and he is credited with having organised in 1872–73 the first laboratory in the United States for research in the applied sciences of engineering. Among some of the more important results of this work of Dr. Thurston may be mentioned the determination of the useful qualities of alloys of copper and tin and copper and zinc; his studies and conclusions upon boiler explosions; his investigation of the laws of friction and lubrication, and of the laws of variation of engine-waste in heat and power; and his studies in the field of the commercial economy of steam engines.

As an engineering expert, the United States Government frequently demanded the services of Dr. Thurston.

GERMAN RÉSUMÉ.

BERLIN, November 21st, 1903.

The Zossen High-Speed Trials.

The great success reported last month has been surpassed by the latest experiments on the Berlin-Zossen line. On the one hand, the Siemens' car, which first was allowed to show its possibilities, reached speeds as high as 207 kilometres per hour on October 23rd on a gradient of 1·200, corresponding with 210 kilometres on the horizontal line. On the other hand, the A.E.G. car, commencing the trials after the 200-kilometre record run of its rival, rapidly made up for the delay occasioned by some reconstructions. After using for a time moderate speeds of about 100 kilometres so as to ascertain the working conditions of the car, it was possible to increase the speed of the latter, until on October 28th a maximum speed of 210·2 kilometres was reached. Both cars have thus proved equal in strength, the small differences in the maximum speeds being as a matter of course due to quite accidental conditions of the current supply. The respective qualities of either car will have to be ascertained by the further course of the trials. It is not intended driving the maximum speed to any materially higher figures for some time, though both the cars and the track are likely to stand considerably higher strains.

In addition to the rebuilding of the track, the road-bed of which gave most satisfactory results, the mechanical part of the high-speed cars had also been somewhat modified before this year's experiments were begun, former trials having shown the distance of the wheels to be too small, any irregularity of the track resulting in shocks to the car. In addition to strengthening the frames of the trucks and to improving the suspension springs, the distance of the wheels was therefore increased. The body of the car was left unaltered, but for its being placed on each truck in four steps, the centre bolt being mounted not rigidly but between strong plate springs, so as to considerably diminish the transmission of lateral shocks to the truck. The Siemens' and A.E.G. cars are little different as to their exterior form, but for the former being a metre longer and somewhat narrower than the latter. These small differences are, however, likely to give interesting results as to the influence of the form of the carriage on the air resistance of the rapidly moving car, this resistance increasing most rapidly for augmenting speeds and finally consuming by far the greater part of the energy. As regards the electric equipment, there are more essential differences, the four motors driving the Siemens' car being mounted rigidly on the axles, whereas in the A.E.G. car they are placed on springs in a frame fixed on the axle box. The resistances necessary in starting are in the Siemens' and Halske car made of metal, being operated through a controlling roller, driven by compressed air. With the A.E.G. car on the other hand, starting is obtained through a novel form of liquid resistances, allowing of the output being accurately regulated and an excessive heating of the resistance made impossible. The steering of this apparatus is effected from the motor man's cab through a simple mechanical gearing.

Though the course followed by the two firms was thus rather different, they have both attained satisfactorily the same aim, both equipments having given excellent results.

Generating Superheated Steam.

In a paper recently read before the Verein Deutscher Ingenieure, O. Berner records the results of a very extensive investigation into the production of superheated steam. The specific volume, heating value, and thermic conductivity are especially important in this connection. As regards the specific volume, this is generally calculated from Zeuner's state equation for superheated vapour, the form of which, using the same designations as in the case of the gas laws, is as follows :—

$$pv = RT - Cp^n \quad \ldots\ldots\ldots$$

where constants R and C have the following values :—

$$R = P,\ 00509 \qquad C = O,\ 193 \quad n = 1/4.$$

The heating value of superheated steam is nearly universally expressed by the following equation :—

$$\lambda = 606,\ 5 + 0,\ 305\ t_1 + 0,\ 48\ (t'_1 - t_1),$$

where the two former terms of the sum represent the liquid and vaporisation heats, the last one the superheat.

Our knowledge as to the thermic conductivity of superheated steam is limited to hypotheses and isolated experiences, very small figures being anticipated from certain phenomena.

After discussing the advantages of cast-iron superheaters as against superheaters of forgeable material, the following conclusion is drawn from some considerations on the passage of heat through the superheating surface; in superheaters using the whole of the smoke gases in superheating the steam, the relation between the work performed by the boiler and the co-efficient of the passage of heat will not show any material departures from a linear formula, both factors thus being approximately proportional.

With regard to the speeds of the steam in the superheated tubes, as dealt with in the fourth part of this paper, the following factors have to be taken into consideration when choosing a convenient value for this speed: passage of heat, durability, and fall in tension. The speeds recorded vary between 4 and 28 m/sc. The utilisation of heat in producing superheated steam is treated in the fifth part, the connections between the superheater and the boiler being of paramount importance. The determination of the efficiency in the case of superheaters with special fireplaces is difficult on account of the considerable influence exerted by a lack of knowledge as to the specific heat and the amount of water contained by the entering steam. It is shown that by fitting steam generating plants with such superheaters, the efficiency is lowered only by a little less than five per cent., provided both the boiler and superheater are well utilised. Building superheaters into the boiler will result in increased efficiency of the latter, the original boiler being modified in two respects, as both the heating and radiating surfaces of the boiler are augmented by the superheater surface. The work done by the boiler in generating superheated steam is discussed in the last chapter, this factor being modified for two reasons when modifying the connection of the superheat with the boiler, viz., first by the alteration in the temperature fall controlling the passage of heat between smoke gases and water; secondly, by the modification of the relative position of some heating surface elements of the boiler with regard to the fireplace, controlling to a high extent the efficiency of the boiler heating surfaces. It is shown that compound hot steam locomobiles working at steam temperatures upwards of 300° C. require a simpler and cheaper steam generating plant than wet steam locomobiles of the same output. The use of superheated steam will, therefore, in addition to the advantage of greater economy, be advisable also on account of the lower first cost of the steam generating plant.

Magnetic Phenomena.

Among the papers read before the Physical section of the Congress of German Naturalists at Kassel, we note a paper by Mr. Zacharias, suggesting quite a novel idea on the nature of magnetic phenomena. Though the writer does not wish to endorse the views of the author, who considers magnetism to be due to "mechanical phenomena," we purpose giving a brief account of them, the more so, as they have repeatedly been discussed of late before German learned societies.

The author has ever since 1880 been engaged in magnetical researches, resulting in some singular magnets being designed and new facts noted. He thinks the usual statement of the existence of two poles in the iron core and iron shell not to be true, on account of the high increase in strength obtained by the use of an iron shell in connection with an electro-magnet. Nor does Mr. Zacharias adopt the usual views on magnetic influence, assuming the direction of motion of the magnetic force to be exclusively due to the wire coils, the iron outside of the latter exerting only a resistance against the force directed towards the magnet and its iron core. The author attempts to show, by the aid of photographic records, that an iron armature, instead of becoming itself a magnet, in accordance with current views, is nothing but a resistance. Mr. Zacharias is equally opposed to the view that iron should be a good conductor to the induction flux. He, on the other hand, explains magnetic forces by the existence of a *pressure difference*, produced by ether waves acting on the iron core. The connection between light, heat, electricity, and magnetism receives further evidence by some experiments on refraction and reflection of magnetic waves in iron sheet prisms, lenses, and concave mirrors.

When considering the iron-filing image of a straight electro-magnet, more or less curved lines are noted between the ends of the iron core, according to the greater or lesser intensity of the magnetising force. Now, the electric motion in the coil surrounding the iron core gives rise, according to Mr. Zacharias, to a corresponding motion both of the intra-molecular and free ethers, forming the so-called indifference zone in the centre, whereas ether pressure, being the magnetic force, is produced at the ends. The rotation of the ether in the magnetic field gives rise in the iron core also to a certain ether vacuum; the higher the latter, the greater will be the force at the ends of the core. The author thinks some phenomena, as, for instance, the motion of electricity in wire coils, to be an evidence of the existence of such rotations. In the case of direct current, the rotation occurs in the same direction; in that of alternating current, in alternating directions, the vacuum and, accordingly, the force thus being present in both cases, whereas the so-called polarity or directive force, is dependent on the direction of rotation.

Mr. Zacharias attempts to show the mutual action between a magnetic rod and a magnetic needle on the instance of two rotating spheres, one of which is suspended by a thread, exerting one on another a repulsion when in the same directions, while they are found to adhere when turning in opposite directions.

Magnetism would, accordingly, be a phenomenon of motion instead of an equilibrium phenomenon, this applying also to the case of permanent magnets. The author, it is true, was not for some time able to account for the conservation of motion of the ether in the case of permanent magnets. Now that he has succeeded in designing non-polar magnets, he has shown all matter to be always surrounded by ether vibrations. He thinks the difference between electro magnets and permanent-magnets to be due to the fact that in the former case an artificial motion of ether is produced by the electric current, whereas in the latter case the proper vibrations of the steel molecule are operative in connection with the intra-molecular ether. As iron opposes resistance to magnetic waves, it not only adheres to magnets of any kind, but produces the deviation of a movable magnetic needle by a partial elimination of pressure,

Obtaining Dense Castings by means of Thermite.

In a paper recently read in Düsseldorf, Mr. W. Mathesius suggests utilising thermite to obtain dense castings (*i.e.*, free from pores) from grey iron and steel. The effect of thermite on the metal to be cast, viz., the metal bar, is a treble one; the metal given off from the thermite during the combustion is alloyed to the bath in the moment of its production, the bath absorbs heat from the heat of reaction, and finally a violent intermixing of the bath takes place. The combustion of thermite, as is known, takes place without any supply of gases being necessary and without the formation of any gaseous products in the reaction; this substance is essentially a mixture of finely divided aluminium and metal oxide, burning with the evolution of great amounts of heat, the metal being given off, whereas the aluminium is burned to aluminium oxide, given off in the molten state as corundum. The perforated sheet metal box where thermite is generally burnt, is in the case of grey iron slipped centrically on a dry iron bar free from rust, and afterwards, having preheated, to a moderate temperature, is introduced into the liquid metal placed in the casting crucible, until the reaction is completed after 1 to 1½ minutes. This process results in castings of much finer and absolutely dense structure and excellent polishing capacity being produced, on account of the extremely divided graphite. The supply of heat will, in the case of sufficiently high quantities, exceed the heat losses by radiation. The metal, after the reaction, is perfectly free from gases and is not found to spit any more. The thermite to be used in connection with grey iron is titanium thermite, containing titanium oxide along with iron oxide. Titanium is capable of binding nitrogen in the hot liquid cast iron, even when present in small percentages. The liquid casting is thus enabled to compensate for the noxious influence of the air accumulating during the casting process, the atmospheric nitrogen being bound in the form of titanium cyanide and the iron monoxide formed by the oxygen of air dissolved in the liquid. The strength of the iron in itself is little increased by the thermite treatment, which, however, enables hard or soft castings to be produced by adding ferro-manganese or ferro-silicium to the casting.

SOUTH AFRICAN RÉSUMÉ.

JOHANNESBURG, November 10th, 1903.

Cost of Shaft Sinking.

The following figures, with reference to the eastern incline shaft of the New Kleinfontein Gold Mining Company will be of interest to mining engineers in other countries. They cover the cost of sinking from January 1st to May 31st, 1903, the distance sunk during that period being 858 ft. The average per month was, therefore, 171·6 ft., while the best result was 213·5 ft. in May. The size of the shaft is 21 ft. by 6 ft. in the clear and all the unskilled work was done by kafirs.

In addition to the tabulated costs, the following particulars have been published by Mr. Way, the general manager of this group of mines. In 144 working days, 4,032 holes were bored, aggregating 28,963 ft. or an average of 7 ft. 2·2 in. per hole. Looked at in another way this means 33·76 ft. of drilling for each foot sunk :—

Items.	Total cost.			Cost per foot sunk.		
	£	s.	d.	£	s.	d.
White wages	3,292	10	0	3	16	9
Salaries	276	8	5	0	6	5
Native wages	1,190	4	8	1	7	9
Native compound expenses	616	11	3	0	14	5
Workshops	108	13	2	0	2	6½
Steam	1,353	3	3	1	11	6
Rock drills	2,620	1	2	3	1	1
Surveying	40	10	11	0	0	11¼
Transport	13	10	0	0	0	3¾
Travelling expenses ..	3	0	0	0	0	1
Stores —						
Gelatine	1,463	0	0	1	14	1¼
Rails	325	6	0	0	7	0½
Candles	135	3	4	0	3	1
Timber, various	71	16	6	0	1	8
Fuse	42	3	6	0	1	0
Steel bars	45	1	0	0	1	0¼
Fish plates	35	19	4	0	0	10¼
Piping	21	7	6	0	0	6
Bolts and nuts	18	6	0	0	0	5
Sleepers	18	1	7	0	0	5
Detonators	16	15	4	0	0	4¾
Tools	11	6	8	0	0	3¼
Dog spikes	7	2	4	0	0	2
Oils and grease	7	2	4	0	0	2
Iron bars, etc.	7	0	8	0	0	2
Nails	4	15	10	0	0	1¼
Coach screws	1	6	8	0	0	0½
Sundries	80	5	9	0	2	1
	11,835	10	5	13	15	11

The Barberton District.

This once famous district is at the present time passing through one of those periods of depression and neglect which are common to all quartz mining districts. The following particulars, condensed from a series of able articles which have recently appeared in the Johannesburg *Star*, supplemented by the official returns of the Witwatersrand Chamber of Mines, will substantiate the above statement.

There are more than 250 mining properties, of which about 50 are in the hands of registered companies or syndicates, but very few of these are being worked at all, and a still smaller number are actually producing gold.

The Sheba mine continues to be the largest producer, but it is crushing ore of very much lower grade than formerly, part of its present output of gold being obtained by the treatment of old slimes which accumulated in earlier and more prosperous days.

The following figures give the working results for August, 1903 :—

Number of stamps, 115.
Duty, 2·90 tons per stamp per day.
Tons mined 9,369.

	Tonnage.	Ounces fine gold.	Value.	Dwts. per ton.	Dwts. per ton milled.
Milled ..	9,559	884·13	£3,756	1·85	1·85
Concentrates produced ..	139	467·23	1,985	67·23	0·98
Sand treated	6,310	754·59	3,205	2·39	1·58
Slimes treated	3,773	408·27	1,734	2·16	0·85
		2,514·22	£10,680		5·26

As the returns from the old slimes are not separately stated, the exact value of the ore now being crushed cannot be ascertained from the above figures, but it is evidently less than the total of the last column, namely, 5·26 dwts. per ton. Of course this refers to the realisable value and not to the original contents of the ore. On ore of such a grade it needs favourable conditions and good management to work at a profit in this district.

Other Mines.

The United Ivy mine at Moodies is being worked on tribute on a small scale, the tributor having an option to purchase. The Clutha and the Barrett mines complete the list of producers in the August returns with results as under :—

Mine.	Tons milled.	Gold in ozs.	Value.	Dwts. per ton.
Barrett	2,600	363·48	£1,544	2·80
Clutha	1,442	231	983	3·20
United Ivy ..	1,100	377·85	1,605	6·87

Important development is being carried on at some half dozen other properties with more or less success, but with these few exceptions Barberton may be said to be hibernating during "the winter of its discontent," waiting for the return of the doubtless wicked but very desirable capitalist.

Lydenburg.

This district can only show two producing companies whose results are given below while the banks return over 500 ounces of gold received from workers on a small scale :—

Mine.	Tons milled.	Gold in ozs.	Value.	Dwts per ton.
Glynn Lydenburg ..	1,960	1,391	£5,900	14·19
Transvaal G.M. Estates	5,000	3,607	15,322	12·74

Klerksdorp.

This district returns only 330·1 ozs., worth £1,402, from 2,600 tons crushed, equal to 2·54 dwts. per ton from one producing company, namely, the Klerksdorp Gold and Diamond Mining Company.

A note on the Labour Commission will be found on page 549.—Ed.

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

ELECTRICAL PROGRESS AND LEGISLATIVE IMPEDIMENTS.

MR. R. KAYE GRAY'S presidential address to the Institution of Electrical Engineers contained an admirable survey of the progress of the electrical world, and gave considerable attention to the special points connected with existing legislation as affecting electrical enterprise. The following is an abstract :—

LEGISLATION OF TWENTY YEARS AGO.

If they omitted the Electric Lighting (Clauses) Act of 1899, which merely codified the provisions usually incorporated in a provisional order granted by the Board of Trade, they found that there had been no public legislation upon the generation and distribution of electricity since 1888, when an Act was passed to amend certain defects in the original Act of 1882. This absence of legislation during a period in which the applications of electricity to the service of mankind had been enormously improved and extended, would not have been remarkable if the original Acts had been adequate, not only to the needs of the time at which they were passed, but to those of the present day ; but, as everyone knew, this was far from being the case. Those statutes were framed to meet the case of distribution of electricity over a small area, and no provision was made for the time, which had long since arrived, when it would be possible and even economical to distribute from a given centre over a wide area, extending far beyond the boundaries of any particular parish or municipality. There might have still been a chance that the parochial idea embodied in these early statutes would, in the course of time, have been abandoned, had not Parliament fixed this idea as a permanent feature of British electrical distribution by giving to the local authorities the right of purchase of the undertakings supplying their areas after a period which was first stated at 21 years, but afterwards extended by the Act of 1888, to 42 years. In addition to this, the Act of 1888, although intended to promote the introduction of electric lighting, went far towards stifling private enterprise in this direction, by giving to the local authorities a veto on any petition to supply electricity within their areas. Thus it has come to pass that in spite of the great progress made since 1888 in the science of distribution, no one but a local authority could to-day obtain free unimpeded access to the Board of Trade with a petition for a provisional order, and as local authorities were as jealous of one another as they were of private companies, the general result was that the municipal area was still the unit area for distribution.

THE NEW MEASURE TO BE PRESSED FORWARD.

There were, of course, many other prominent defects in the Electric Lighting Acts. They did not, for example, provide for the compulsory purchase and sale of sites for generating stations, nor yet for the erection of these stations outside the area of supply. If promoters of an undertaking desired either of these things they had to proceed by special Act, not by provisional order ; and the best proof of the inadequacy of the Electric Lighting Acts to modern needs was that these private Acts usually contained special clauses, of which the object was to render inapplicable a larger or smaller number of the sections of the controlling public statutes. The whole subject was considered in 1898 by Lord Cross's Committee, which made many recommendations of the highest value—among them the abolition of the veto and the removal of the defects just noticed ; but until the present year the Government had shown no sign of being desirous or willing to give these recommendations the force of law.

The Institution of Electrical Engineers, which had always been alive to the serious consequences of this defective legislation, sought in June of last year to bring pressure upon the Government by sending a deputation to the President of the Board of Trade. It was impossible to express more forcibly or more clearly the objections to the present law than was done by the members of the deputation on that occasion ; but, although they were then promised a measure to remove these objections, nothing was attempted until May of this year, when a Bill, embodying most of the recommendations of Lord Cross's Committee was introduced in the House of Lords by Lord Wolverton at the instance of the Board of Trade. But the Bill did not go beyond the introductory stage, and at the close of the session no progress had been made. The measure, however, ought not to be allowed to drop ; and as the President of the Board of Trade had told them that his department desired to "press forward" this measure when opportunity offered, it was to be hoped that next session it may not only be introduced, but may be placed upon the statute book.

LARGE POWER SCHEMES AND MUNICIPAL ENTERPRISE.

With regard to the distribution of electricity for power purposes, the Electric Lighting Acts made no special provision. Any consumer might use his supply either for lighting or power, or both. But in recent years the idea of promoting large power schemes to supply very wide areas had become prominently to the front, and since 1900 several such schemes had been authorised by special Acts of Parliament. The powers of supply conferred upon companies under these Acts were twofold ; they might supply energy for power purposes to any person, and they might supply energy in bulk to authorised distributors. In this connection it might be noted that if the Bill introduced by Lord Wolverton became law it would be possible to obtain powers for supply in bulk to authorised distributors by provisional order, instead of proceeding, as at present, by special Act. The most important point, however, about these modern power schemes was that in many cases the promoters come into sharp conflict with local authorities and other authorised distributors supplying urban or rural districts within a large area which they desired to cover by their scheme. The local authorities were especially antagonistic to any proposal which would allow another body to come into their area to supply electricity, and in some cases Parliament had cut out, from the area which a particular scheme desired to cover, various towns and districts possessing their own electricity supply undertakings. It seemed desirable that the local authorities should consider carefully the advantages of taking their supply in bulk from a power scheme instead of generating for themselves on a small scale. In very many cases it would be much more economical to do so, and they would still be left the sole distributors in their own areas. But if local authorities would not do this, Parliament must consider what is best for the country at large; and as the rural districts must obviously gain by the supply of electrical energy at cheap rates, the towns should not be allowed to prevent this gain by obstructing or rendering ineffective the scheme for the larger area. The point was, that if all the towns which constitute the "fat" districts, were cut out of these schemes, leaving only the "lean" rural districts for the large area companies, there could be little or no hope of financial success. In order to obtain, therefore, the greatest good for the greatest number, the larger authority ought to be allowed wherever possible to prevail over the smaller municipalities opposing it, especially when they considered that this did not entail an injustice to these municipalities, but only a slight narrowing of the field of municipal enterprise.

TINKERING TRAMWAY LEGISLATION.

It remained to consider what was, perhaps, the most remarkable feature in recent electrical progress —the development of the electric tramway. The law relating to this branch of the subject was, unfortunately, still more unsatisfactory than that dealing with lighting and power, for the controlling Act was still the Tramways Act of 1870, which was passed before electric traction was introduced, and was intended to deal simply with the ordinary horse-tramway. The defects of that Act were too well known to require mention; the objectionable veto given to the local authorities had once more been sufficient in itself to retard progress to an extraordinary degree. The fact that in the last few years electric tramways had developed so much in this country was not due to the existence of the Tramways Act, but principally to the fact that it was found possible to evade that Act to a considerable extent by promoting these concerns under the Light Railways Act, 1896 —an Act which was really intended for another class of undertaking altogether. That Act had proved beneficial to a high degree, as it lowered the cost and simplified the procedure when a tramway scheme was promoted; but in the years during which it had been in operation various defects had been discovered and attempts had from time to time been made to have them remedied. Mr. Gray's predecessor, Mr. Swinburne, had pointed out these defects to the President of the Board of Trade when a deputation waited upon that Minister last year, and here, again, they were promised a measure to remedy them. A Bill *was* introduced this year, but it was unsatisfactory in the extreme, as it made no attempt to deal with the whole subject, but merely tinkered at one or two details; and they could not regret, therefore, that it had made no progress. The Board of Trade had previously appointed a committee to consider what amendments of the Act of 1896 were desirable, and as the President of the Board of Trade told their deputation that a report had been received from that committee, they naturally expected that the new Bill would deal comprehensively with the subject, but in this they had been disappointed. The old Tramways Act ought to be repealed and replaced by a measure suitable for modern needs. Under the Light Railways Act the powers of the Commissioners might with great advantage be extended. At present they were hampered by the feeling that, if not bound by the letter of the Tramways Act, they must, as far as possible, respect its spirit; and hence the absence of consents from local authorities had more weight than was proper. In cases where a light railway scheme was likely to compete with an existing railway company, the provision that the promoters must proceed by private Bill, and not by an inquiry before the Light Railway Commissioners, also militated considerably against the usefulness of the Light Railways Act by curtailing the powers of the Commissioners; and this restriction ought to receive attention in any amending measure.

These were but a few of the numerous points in the present law which called for attention. The whole of our electrical legislation was in urgent need of reform; and, after so many promises had been made, it would be very regrettable if nothing was done to remove the existing defects.

POWERS FOR CONVERTING TO ELECTRIC TRACTION.

While the electric light and power undertakings had obtained but little legislation in their favour, it was a relief to see that Parliament had granted railway companies certain advantages. By the Railways (Electrical Power) Act, which received the Royal assent on August 14th last, existing railway companies desiring to convert any of their lines to electric traction were enabled to obtain sufficient powers for so doing by means of an order of the Board of Trade. They might become interested in power companies, and might take from them electrical energy for the supply of their main or branch lines.

IN SPITE OF LEGAL RESTRICTIONS.

In spite of the legal impediments referred to, it would be found on investigation that substantial progress had been made in Great Britain in the utilisation of the electric current for both light and power purposes. Exclusive of traction motors, in March of this year, lamps and motors equivalent to over 14,000,000 eight-c.p. lamps were connected to the mains of public electricity supply undertakings, the metropolis being represented to the extent of about 5,000,000. There were about three hundred towns enjoying the advantage of an electricity supply, this number including, with two exceptions, all the towns whose population exceeds 100,000. The exceptions were Tottenham and the Rhondda district, which did not seem anxious to be alongside of their thirty-eight fellows. It appeared that at this period, exclusive of power companies, the public supply stations had motors amounting to 55,000 h.p., connected to their mains. Municipal undertakings owned generating plant of a rated capacity of 320,000 kilowatts, and private undertakings were represented by 160,000. In the metropolis the companies were proprietors of about 100,000 kilowatts, whereas the public bodies were responsible for, approximately, 28,000. The pre-eminence of the companies in London was due to the fact that they acted as pioneers, and were first in the field. The average rated capacity of a British station appeared to be about 1,400 kilowatts. It was to be remarked that, while in the provinces the average municipal station had a capacity of nearly three times that of a company station, in the metropolis the ratio was reversed. Again, the average metropolitan company had approximately, ten times the plant capacity of the average provincial company.

DIRECT CURRENT UNDERTAKINGS.

It was interesting in this investigation to note that modern tendencies in this country were decidedly in favour of the direct-current system with a three-wire distribution. The number of direct-current undertakings increased from 139 in 1901 to 214 in 1902, and 260 in 1903. For these three years the alternating current stations numbered 67, 68, and 69 respectively.

(*To be continued.*)

OUR PROGRESS IN SHIPBUILDING.

IN the course of a remarkable presidential address to the Institution of Civil Engineers, Sir W. H. White, K.C.B., F.R.S., attributed our superiority in shipbuilding to the lead we took in the introduction of iron into steamships, the advantages resulting from the training of two generations of skilled workers, and the enterprise of owners and builders. He carefully reviewed the progress made in British shipbuilding and engineering during the past forty-four years. A brief abstract follows :—

The main lines of advance in shipbuilding since 1859 were dealt with under three main heads : (1) Improvements in marine engineering, leading to large economies in weight of machinery and fuel ; (2) improvements in materials, both as regards strength and the forms in which they were furnished by manufacturers ; and (3) the larger use of scientific methods in design.

BOILER PRESSURE.

The pressures used in marine boilers in 1859 were only from 20 lb. or 25 lb. per square inch, while now pressures of 210 lb. or 220 lb. were common in the mercantile marine with ordinary water-tank cylindrical boilers, and a little less than 270 lb. had been reached in a few cases. For warships with water-tube boilers 250 lb. to 300 lb. had been used for nine years ; but in the most recent vessels, in which 20 per cent. of the total power was in cylindrical boilers, the rest being in water-tube boilers, the pressure was only 210 lb. This rise in pressure had been associated with triple or quadruple expansion engines, and was accompanied by an increased rate of revolution and piston speed.

ECONOMIES IN WEIGHT AND FUEL.

In 1859 each ton of propelling machinery in full working order gave about 6 i.h.p., whereas in present practice about 9 i.h.p. was obtained in battleships with cylindrical boilers, and 10½ i.h.p. with water-tube boilers. In the *Drake* class about 12 i.h.p. was obtained per ton, and in destroyers 40 or 50. As to economy of fuel, the best direct-acting engines in screw steamers of 1859, with 20 lb. or 25 lb. pressure, required from 3¾ lb. to 5 lb. of coal per i.h.p. per hour ; now the average was about 1½ lb. for ocean-going vessels with triple or quadruple expansion engines.

TWIN AND TRIPLE SCREWS.

After references to the influence exerted on marine engineering by the departure taken by Sir John Thornycroft about thirty years ago in the construction of small swift boats with engines and boilers of remarkable lightness in proportion to the power developed, and to the development of the Parsons turbine, the President discussed the advantages of twin screws and triple screws. Thorough analysis of the actual performances of many ships enabled him to state that triple screws did not give better propulsive efficiency than twin screws, but no doubt the time would come when it would be desirable, if the present progress continued to fit vessels with triple screws.

WATER-TUBE BOILERS.

Coming to the question of water-tube boilers, he recalled the circumstances in which they were adopted for the *Powerful* and the *Terrible* in 1893, and submitted that there was no reason, in the light of subsequent events, for apology or regret for the action then taken ; on the contrary, he thought it had had greatly beneficial results for the Royal Navy itself, and was destined to have far-reaching effects upon steamship design generally. Into the controversies of the last four years he did not propose to enter. All that was necessary now was to state his conviction that those who had taken the most prominent part in attacking the policy of the Admiralty had exhibited an imperfect knowledge of facts and principles ; had failed to appreciate the weight of authority against their contention, represented by the universal agreement of naval authorities in all countries, that water-tube boilers were essential to modern warships ; and had shown, in many instances, a spirit of prejudice and personality that should never have been displayed in the discussion of a technical subject affecting the naval defence of the Empire.

EFFECT OF SCIENTIFIC RESEARCH.

In the course of his remarks on the effect upon shipbuilding of scientific research, he said an endeavour he had made thirty years ago to secure data respecting the experimental results and qualities of merchant ships had resulted in little, chiefly because little information of the kind had been obtained or recorded ; but since that time the record and scientific analysis of results, as well as the conduct of experiments and the thorough investigation of all features in design, had greatly developed. In warship work the Admiralty practice had been continuously marked by scientific procedure, though there also, there had been marked advance since 1860. It was proper to state that the supply of men competent to do the new work, and thoroughly trained as naval architects, was mainly due to the enlightened policy of the Admiralty in establishing and maintaining schools of naval architecture. The structural strength of ships had been made the subject of scientific investigation since iron came into use. The latest step taken in this direction by the committee appointed by the Admiralty to examine into the strength of destroyers had great interest, for a destroyer, suitably supported in dock, had been subjected to bending moments approximating to those calculated on the usual hypothesis, and the actual stresses at various points determined by stress-indicators. Perhaps the greatest advance in scientific method was that connected with experimental determinations, inaugurated by William Froude, of the water resistance to the motions of ships. Apart from model experiments, progressive steam trials of ships furnished valuable assistance in steamship design. Questions of screw efficiency were in fact best dealt with by such trials, for, although modern experiments gave much valuable information, they could not be trusted as yet for the certain selection of the propellers most suitable for any particular case.

MERCHANT SHIPPING IN 1903.

Dealing with merchant shipping in 1903, the President remarked that since 1860 the tonnage shown on the Register of Shipping for the United Kingdom had been increased about two and a half times. At the end of 1902 the lists showed 9,152 vessels of about 14,900,000 tons (gross). British possessions owned 1,982 vessels of 1,117,000 tons. The total for the Empire was 11,134 vessels, aggregating over sixteen millions tons. All other maritime countries combined owned 18,809 ships, with an aggregate tonnage of about 17,637,000 tons.

COST OF SPEED.

What had been the cost of speed in individual ships was not generally recognised. In 1874 the *Germanic* (which last month made her final voyage across the Atlantic) and *Britannic*, of the White Star Line, cost about £200,000, and averaged 15 knots. In 1889 an average speed of 20 knots was associated with a cost of £350,000 to £400,000; and five years later the corresponding figures were 22 knots and about £500,000 to £550,000. In 1899 the *Oceanic* cost £700,000. Particulars of the cost of later ships were not available, but his impression was that probably the *Deutschland* and the *Kaiser Wilhelm II.*, with 23 to 23½ knots speed, involved an expenditure of about £700,000 and £800,000 respectively. While, therefore, the advance from 15 to 20 knots was made for an increase of, say, 80 per cent. in cost, that from 23 to 23½ knots had involved an increase of 100 to 130 per cent. Referring to the new Cunarders, the President said the magnitude and difficulty of the problems involved in the designs of ships required to be from 1¼ to 1½ knots faster than any mail steamer in existence was enormous, and there must inevitably be a great increase in size and power. It would be noted that the agreement contemplated a possible expenditure of £1,300,000 on each ship, which was probably £500,000 (over 60 per cent.) more than had yet been spent on any merchant steamer, and equal to the cost of our most expensive armoured battleships.

During the seventeen years he was at the Admiralty his responsibility for designs and construction included forty-three battleships, twenty-six armoured cruisers, twenty-one first-class protected cruisers, forty-eight second-class, thirty-three third-class, and seventy-four unarmoured or unprotected vessels. The total represented 245 ships, with an aggregate value of about eighty millions sterling. By virtue of her Naval supremacy, England stood among the great Powers of the world.

THE BACTERIAL TREATMENT OF SEWAGE.

At a meeting of the Society of Engineers, held at the Royal United Service Institution, a paper was read on "The Bacterial Treatment of Sewage," by Mr. George Thudichum, F.I.C., F.C.S.

Discussing the best methods of application the author said the two main points which were still being argued were (1) the relative merits of the anaërobic or septic, as compared with the aerobic, or coarse-grain contact system; and (2) the various ways of applying the effluent from the preliminary treatment to the finishing filters.

He gave it as his opinion that the anaërobic process was more in accordance with the teachings of nature, and moreover possessed certain specific advantages over its rival, such as the averaging of the sewage flow; the greater ease with which regular periodic working of the filters could be obtained; the absence of trouble from loss of water capacity through deposition of solids; and the easier and cheaper cleansing if necessary.

The necessity for covering a septic tank was then dealt with, Mr. Thudichum stating that he thought it desirable, since it prevented disturbance of the bacterially active scum, avoided risk of nuisance, and enabled use to be made of the gases evolved during the putrifactive process, as was actually done at Exeter. As regarded the question of the best method of applying the primary effluent to the secondary beds, he hesitated to express an opinion, since excellent results had been obtained by either method, and the evidence available was not yet sufficient to enable a definite verdict to be arrived at.

COMING EVENTS.

December.

1st.—Institution of Civil Engineers: Ordinary Meeting—Junior Engineering Society: General Meeting at Swindon.

2nd.—Liverpool Engineering Society: General Meeting at the Royal Institution.

3rd.—Birmingham University Engineering Society: General Meeting at 5.45 in the Physics Theatre.

4th.—Junior Institution of Engineers: General Meeting at 8 o'clock in the Westminster Palace Hotel.

5th.—Birmingham Association of Mechanical Engineers: Annual Meeting at the Grand Hotel.—Manchester Association of Engineers: General Meeting.—Leeds Association of Engineers: Thirty-eighth Annual Dinner at the Queen's Hotel at 5 p.m.

7th.—Institution of Mechanical Engineers: Graduates' Meeting at 7.30 p.m.—South Staffordshire and East Worcestershire Institute of Mining Engineers: Meeting at 3 p.m. in the University of Birmingham.—Institute of Marine Engineers: General Meeting.

8th.—Institution of Civil Engineers: Ordinary Meeting.

10th.—Mining Institute of Scotland: General Meeting at Hamilton.—Institution of Electrical Engineers: General Meeting at the Institute of Civil Engineers.

12th.—North of England Institute of Mining and Mechanical Engineers: General Meeting at 2 p.m. at Newcastle-on-Tyne.—Birmingham Association of Mechanical Engineers: Visit to the Cable Depot, Hockley Brook.—Staffordshire Iron and Steel Institute: General Meeting.—Manchester Association of Engineers: Annual General Meeting.—Liverpool Engineering Society: Annual Dinner.

14th.—Society of Engineers: Annual General Meeting at 7.30 p.m. at the Royal United Service Institute.—Institute of Marine Engineers: General Meeting.

15th.—Institute of Civil Engineers: Ordinary Meeting at 8 p.m.—Junior Engineering Society: General Meeting at Swindon.

16th.—Liverpool Engineering Society: General Meeting.

17th.—Institution of Electrical Engineers: General Meeting.—Institution of Mining and Metallurgy: General Meeting at Burlington House at 8 p.m.

18th.—Institution of Mechanical Engineers: Monthly Meeting at 8 p.m.—City of London College Science Society: General Meeting at 8 p.m.

21st.—Institute of Marine Engineers: General Meeting.

22nd.—Institution of Civil Engineers: Ordinary Meeting at 8 p.m.

31st.—Leeds Association of Engineers: General Meeting.

OUR DIARY.

October.

22nd.—At Westminster a conference of miners' representatives decides unanimously against Mr. Chamberlain's fiscal scheme and in favour of adhering to Free Trade.

23rd.—Accident to the *Victory* at Portsmouth.

24th. Minor fire on the Paris underground railway.—Señor Silvela, retiring from Spanish public life, says he has come to the melancholy conclusion that at present Spain does not want a fleet, nor an army, nor public instruction.

25th.—Opening of the Congress of non-Social Democratic German workmen.

26th.—The London Traffic Commissioners have returned from the United States.—Lord Avebury at the London Institution on "The Present Position of English Commerce."—The Eleventh Annual Congress of the National Free Labour Association opens.

27th.—Under the auspices of the Post Office a trial of the de Forest System of Wireless Telegraphy is to be made between Holyhead and Dublin.—Our Consul-General at Naples in his latest report speaks of "The wonderful advance in commercial stability which Italy made last year."—The official report in Ceylon for the past year describes the material condition of the people as generally good and with the extension of cultivation and irrigation as well as of railways and public works, there is ample employment, but violent crime is unduly prevalent.—Foundation stone of Pwllheli Harbour Works laid.

28th.—The *Times* Cape Town correspondent reports that though there is a great tightness of money the financial and enonomic situation is on the whole sound.—Resolutions on standard direct current pressures and standard frequencies have been issued by the Engineering Standards Committee.

29th.—Labour troubles at Bilbao continue; at Barcelona a strike of gas workers has thrown out of employment 15,000 operatives in other industries.—Serious riot at Paris in connection with a conference of delegates at the Labour Exchange.

30th.—Consular report describes the past year as a disastrous one for Haytian commerce.—Arrangements said to have been completed to draft 500 convicts for surface labour on the Rand.

31st.—Electrical disturbance affecting the lines and cables of the cable companies described as the worst experienced for the past 14 or 15 years.—At a meeting of the Conciliation Board of the Coal Trade of South Wales and Monmouthshire the consideration of a suggestion for a reduction from the owners' side is adjourned.

During the week the North-Eastern Railway Company carried out some important tests on the York and Scarborough line with the Westinghouse and automatic vacuum brakes fitted upon long and heavy trains.—The electric motor carriage of the General Electrical Company has attained a speed of 130 miles per hour between Berlin and Zossen.

November.

2nd.—End of the miners' strike at Bilbao.—Authoritative statement in Liverpool that the allegation that the American mails will be delivered more quickly by the American line ships than by the Cunard line is incorrect.—Consular report shows that the trade of Costa Rica has been practically stationary during the past year.—The mining industry progresses steadily and the export of precious metals is becoming an important item of trade.—The gold exports from British Borneo have risen from 23,685 dollars in 1898 to over 1¼ millions last year.—A satisfactory report on the condition of Fiji shows that the revenue has increased 40 per cent. in the last five years.—Trial of the "Beedle" airship postponed.—At a meeting of the Durham Coal Trade Conciliation Board it was decided that wages shall remain unaltered for the next three months.

3rd.—The Sanitary Conference sitting at Paris is considering the formation of an International Sanitary Bureau for the collection of information respecting infectious diseases.—Government telegram from New Brunswick reports good opening for coal miners.—Address on ship construction, etc., by Sir W. H. White, K.C.B., D.Sc., President of the Institution of Civil Engineers.

4th.—Commander Peary arrives at Southampton on a commission appointed by the United States Government to inquire into the system of naval barracks in Great Britain.—Important experiments in submarine defence under Admiral Sir John Fisher at Portsmouth.

5th.— The Secretary of the Monmouthshire and South Wales Coal Owners' Association serves upon the South Wales Miners' Federation a formal demand for a reduction of 5 per cent. in the percentages now payable in miners' wages on the standard rates of December, 1879.—A deputation waits on Mr. Long urging the introduction of a Sewage Pollution Bill with a universal charge on all manufacturers who pollute the rivers.—Launch of the third-class cruiser *Amethyst* at Elswick.

6th.—The employers in the shipbuilding trade on the Tyne, Wear and Tees have given notice of a reduction of 5 per cent. on piece rates, and 1s. 6d. per week on time wages.—Naval Agreement Bill providing for an annual contribution of £40,000 unanimously passed by the Government of New Zealand.—The London Traffic Commission resumes its sittings.

7th.—Launch of the Admiralty yatch *Enchantress* at Belfast.—Mr. S. F. Cody, inventor of the war-kite crosses the Channel in his collapsible kite-boat.—Launch of the German battleship *Preussen* at Stettin.

9th.—The Glasgow Chamber of Commerce agrees to a resolution calling for the appointment of a Royal Commission to inquire into the question of fiscal reform.—Prof. C. Le Neve Foster knighted.

11th.—The Cape Premier comments on the fact that the local labour market as regards white labour is congested.

12th.—Mr. R. K. Gray delivers his presidential address to the Institution of Electrical Engineers.

13th.—Collapse of a viaduct in course of erection at Stanway with fatal results.—Successful trip by the Lebaudy steerable balloon from Moisson to Paris.

14th.—Penrhyn quarry strike declared at an end.

16th.—The memorandum prepared by the Labour Department of the Board of Trade states that in the trade unions making returns the proportion of unemployed at the end of October was 5·8 per cent., as against the same percentage in September, and 5 per cent. in October, 1902.

17th.—Publication of the text of the protocol embodying the results of the preliminary conference on Wireless Telegraphy at Berlin in August last.

18th. Issue of the Blue-Book with report by Mr. H. Birchenough on the present position and future prospects of British Trade South Africa.

19th.—Issue of Blue-Book on the naval manœuvres.

20th.—Opening of the Stanley and National Cycle and Motor Shows.

21st.—Report of the Transvaal Labour Commission issued.—Launch of the s.s. *Baltic*, the largest vessel afloat.—Lord Peel, as chairman of the South Wales Coal Conciliation Board, grants owners' demand for 5 per cent. reduction in miners' wages.—Deputation from the Institution of Electrical Engineers present an address to the King of Italy at Windsor.

NEW CATALOGUES & TRADE PUBLICATIONS.

The following Catalogues may be obtained from the firms issuing them, if PAGE'S MAGAZINE *is mentioned when applying.*

Charles Winn and Co., Birmingham (Section D).—A good deal of trouble has obviously been expended on the third edition of this catalogue, which includes some excellent half-tone blocks, illustrating the works of the Company and their products. The latter include a large variety of valves, lubricators, steam whistles, water gauges and fittings, etc Owing to the thoroughness with which the measurements, pressures, etc , have been worked out, it will be found very advantageous to file this catalogue for reference.

T. and M. (Catalogues C 12 and Cl. 1).—The Trading and Manufacturing Company are evidently of the opinion that a catalogue is one of those things which are worth while doing well. Both these catalogues are printed on heavy art paper, and are most creditable productions, whether considered from the point of view of the compiler, designer, illustrator or printer. The first goes thoroughly into the question of filing correspondence. The T. and M. vertical filing system is very carefully explained, and the catalogue should have a wide vogue among the business men for whom it is intended. Catalogue Cl. 1. illustrates the almost innumerable uses of the card system. There are many facsimiles of cards used for various purposes from stock-keeping to dentistry, and prospective users of the card system cannot fail to find the catalogue both suggestive and helpful.

Messrs. W. Watson and Sons, 313, High Holborn, W.C. Microscopes are in such frequent demand, not only for special metallurgical studies, but for the ordinary examination of metal in course of manufacture, that Messrs. Watson and Sons are now making metallurgical microscopes for regular supply. Every detail which is likely to increase accuracy, or facilitate observation, has been embodied in these instruments, which are made in three distinct models, intended both for visual and photographic work. For purely metallurgical work, a microscope of the usual type is certainly not the best possible, but there is no reason why a microscope made primarily for metallurgical work should not be so combined as to be suitable for ordinary investigations, and either of the instruments made by Messrs. Watson and Sons can have extra parts supplied to them so that they may be complete when ordinary direct observations are to be made in addition to the examination of metals. The important features which are highly developed in these metallurgical microscopes include special arrangements for raising and lowering the mechanical stage to and from the nose-piece end of the microscope, a long range of body tube, and a rotating stage, so that the specimen may be viewed from every point and with every variation of illumination. We would strongly advise those who are interested in the subject to obtain from Messrs. Watson a pamphlet which they have just issued on micro outfits for metallurgy. This opens up a fascinating subject in an interesting way, and also gives details of photographic outfits for engineers.

Marion and Co., 22 and 23, Soho Square, London, W.—We have received from this Company a detailed list of heliographic papers and linen, for use in engineering offices, together with some excellent samples of paper. The latter range from thin parchment papers to extra heavy papers, such as are supplied for use in the Government offices. A distinct speciality of this firm is No. 516, which is of strong unmounted linen. Full details of the following papers are included: Marion's Ferro-Prussiate Paper for reproducing tracings etc., in white lines on blue ground, or *vice versa*, by exposure to light and simply washing in water; their Cyanographic Paper for reproducing tracings, etc., in blue lines on white ground; Melagraphic Paper for reproducing tracings, etc., in black lines on white ground by exposure to light and simply washing in water; Marion's Gallate de Fer Paper for reproducing tracings, etc., in black lines on white ground by exposure to light and development in one bath only. Details are also given of new and improved tracing papers and cloths. This pamphlet, which is entitled "Papiers Marion pour Heliocopies," can, with advantage, be filed for reference in the drawing office.

David Brown and Sons, Ltd., Park Works, Lockwood, Huddersfield.—Cut gearing—Machine-cut wheels, a comprehensive catalogue of 180 pages, this book contains valuable information for all who use toothed wheels, and it is worth a special tribute as a time-saver, the firm having introduced ingenious marginal references, which enable one to turn instantly to their worm hob list, giving tabulated statements of the various hobs in stock, to information for determining dimensions of the different kinds of gearing, or to complete tables showing pitch-line and outside diameters. There is a great deal in this catalogue to interest and instruct, and a quantity of data which should be kept on hand for reference.

The Rossendale Belting Co., Ltd., 10, West Mosley-street, Manchester.—A descriptive price list of the "Rossendale" beltings, with full particulars of widths, speeds, etc. It is claimed for the M.A.Y. brand of special patent edged solid woven belting that it will yield an increased production of at least 7 per cent. over leather, hair, or any other woven or composite belt, that it does not stretch or slip, and is not affected by atmospheric changes, and that it resists the action of the strap forks or guides. Particulars are included of the "Rossendale" belt stretchers, which are provided with strong wooden jaws, wrought-iron gearing, screw and lever, while full-page illustrations are devoted to practical applications of the "Rossendale" patent endless belt.

The Standard Engineering Co., Ltd., Welford Road, Leicester.—A small pamphlet has been issued by this Company, including useful tabulated details of Standard Blowers. The plants manufactured by the Standard Engineering Company cover a wide range of industries, such as exhausting plants for extracting flint-dust in potteries, sawdust and chips in saw mills, etc., blowing plants for smith's work, furnace blowing, brazing etc., and fans driven by belt, steam engine, turbine or electric motor. By means of the Standard dust-collecting system for wood-working plant, shavings and sawdust may be collected and deposited in a receiver or sacks, or can be allowed to fall among the fuel for use in the furnace.

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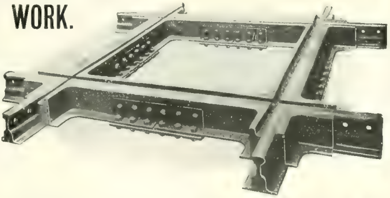

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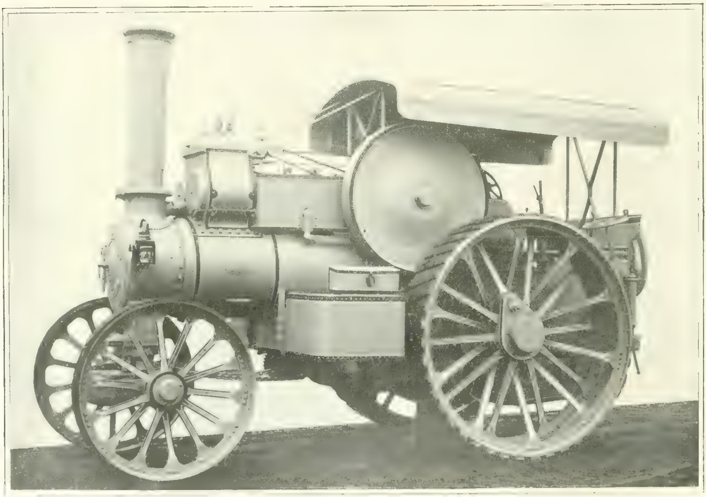

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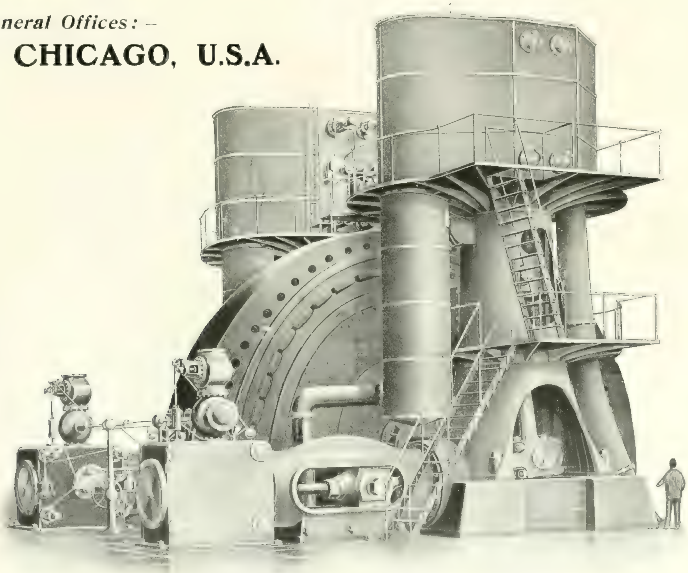

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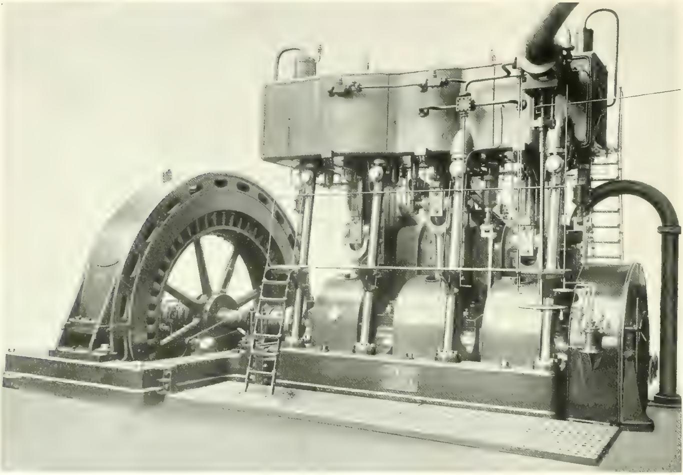

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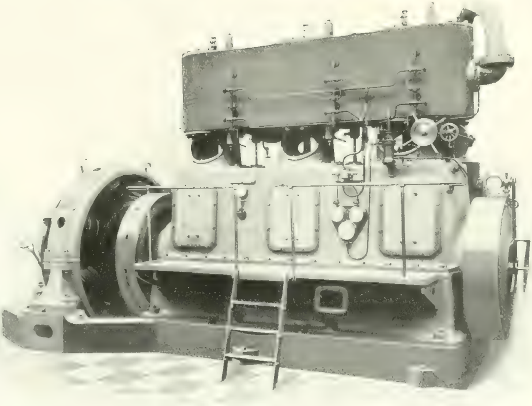

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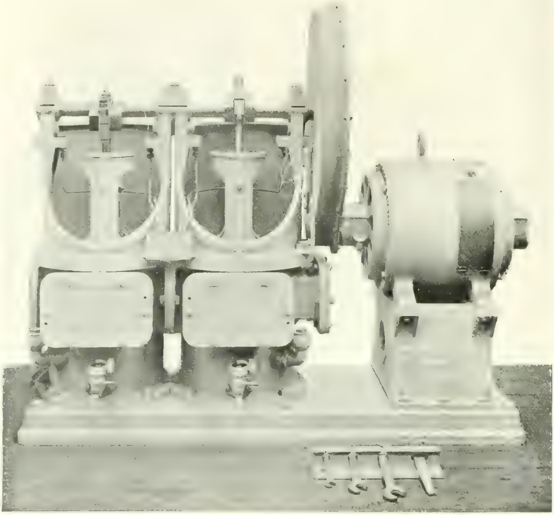

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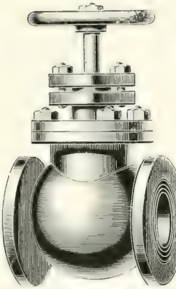

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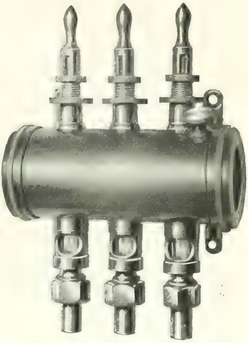

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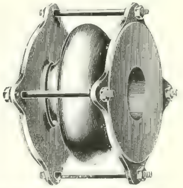

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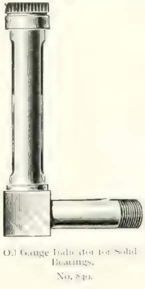

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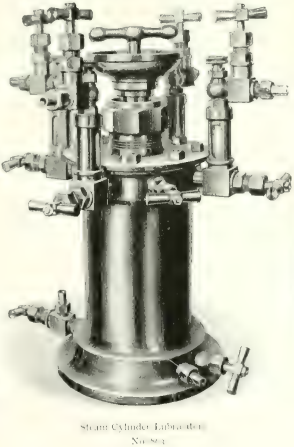

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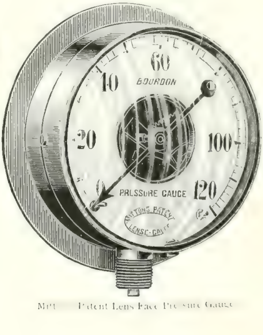

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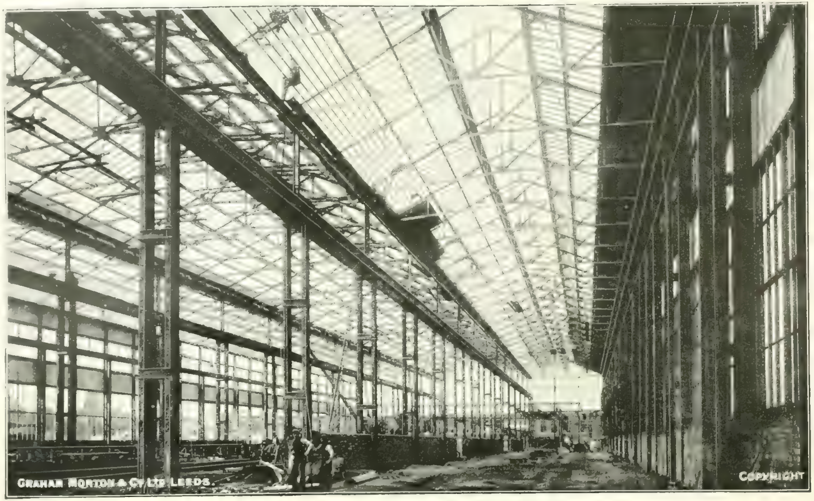

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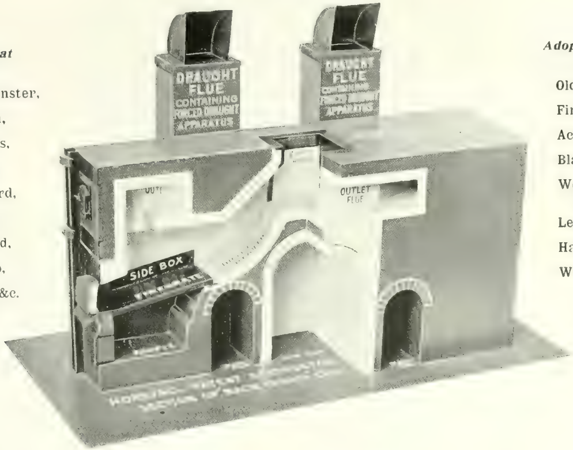
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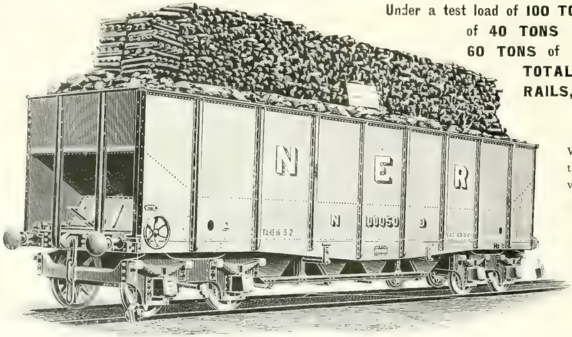

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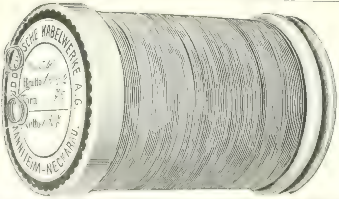

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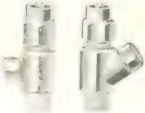

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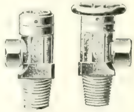

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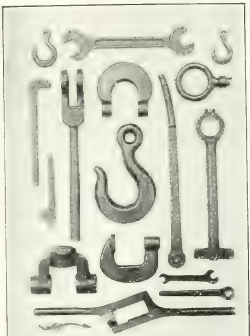

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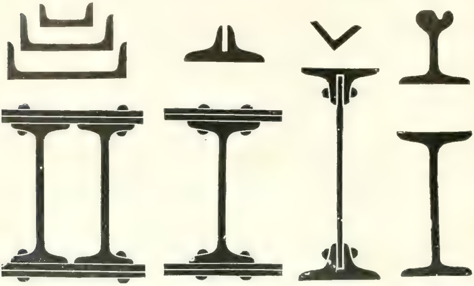

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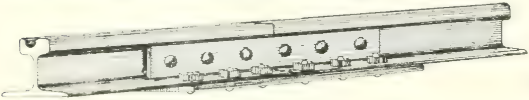

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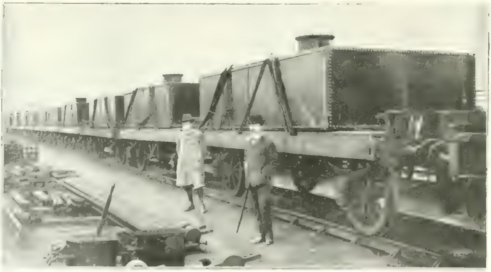

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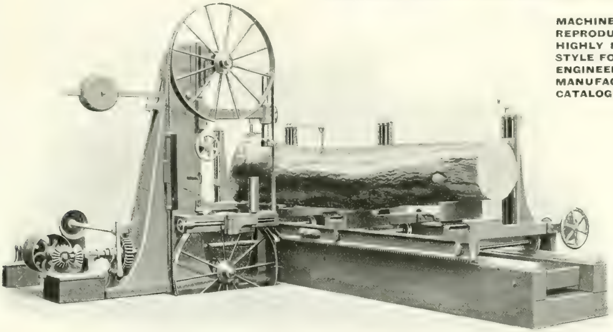

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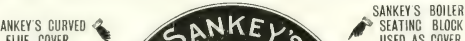

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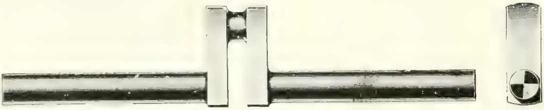

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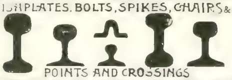

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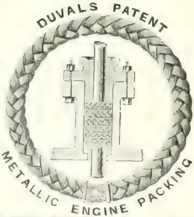

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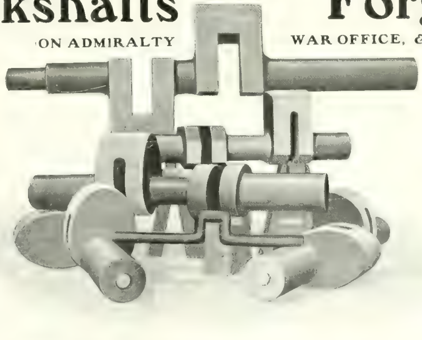

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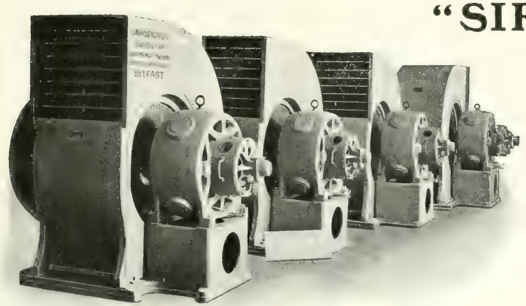

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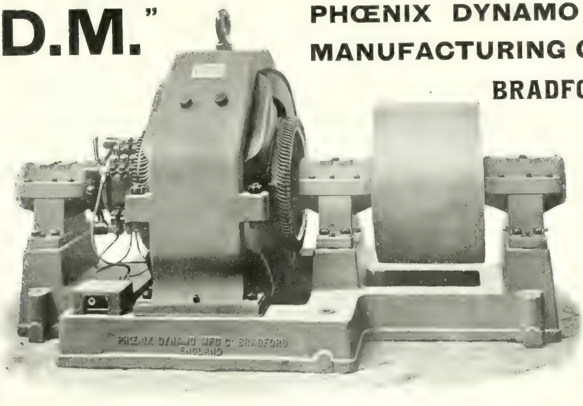

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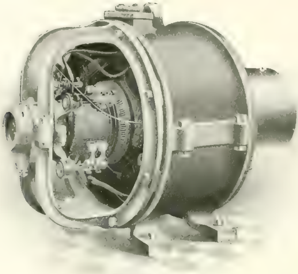

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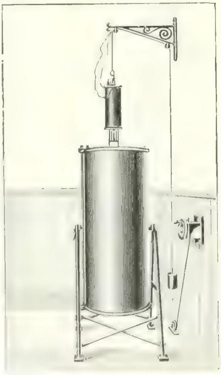

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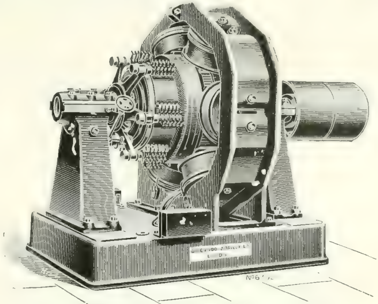

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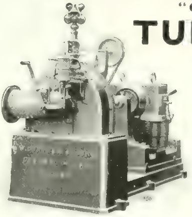

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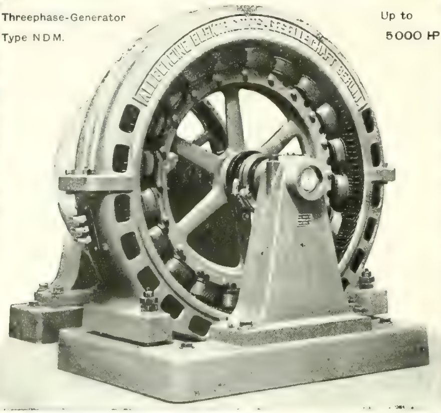

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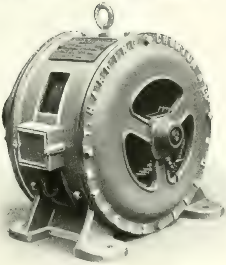

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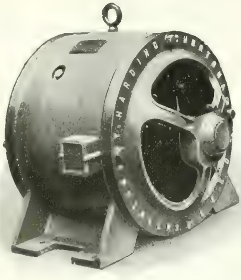

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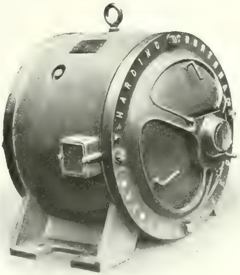

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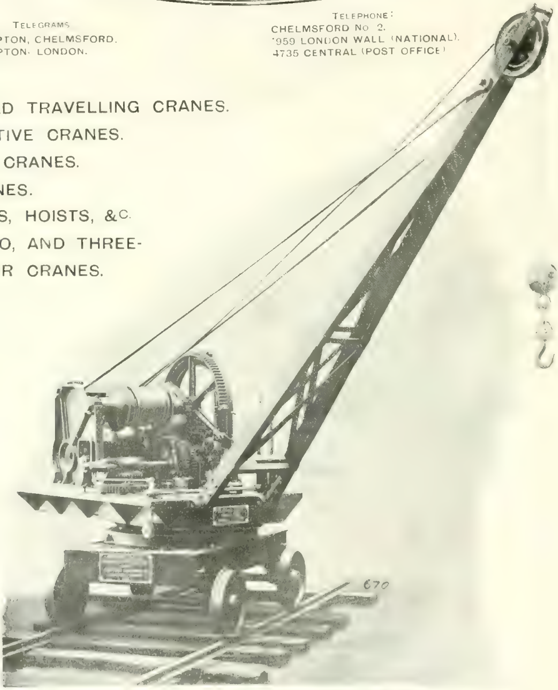

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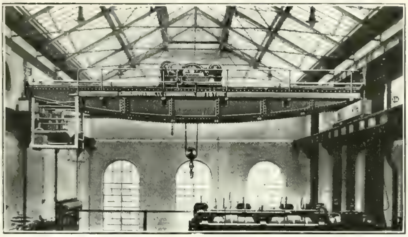

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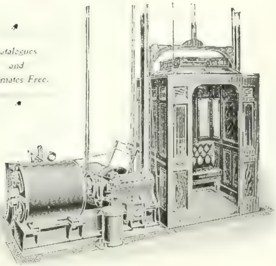

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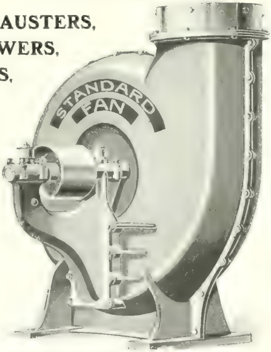

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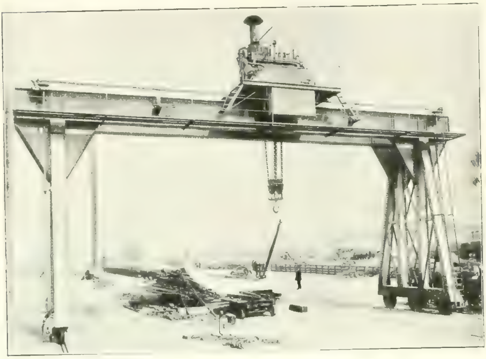

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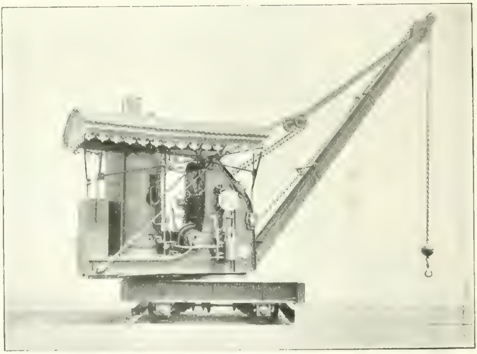

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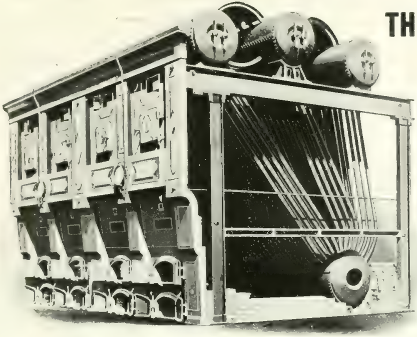

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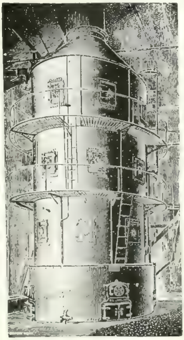

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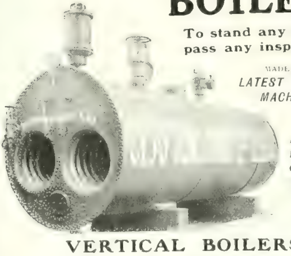

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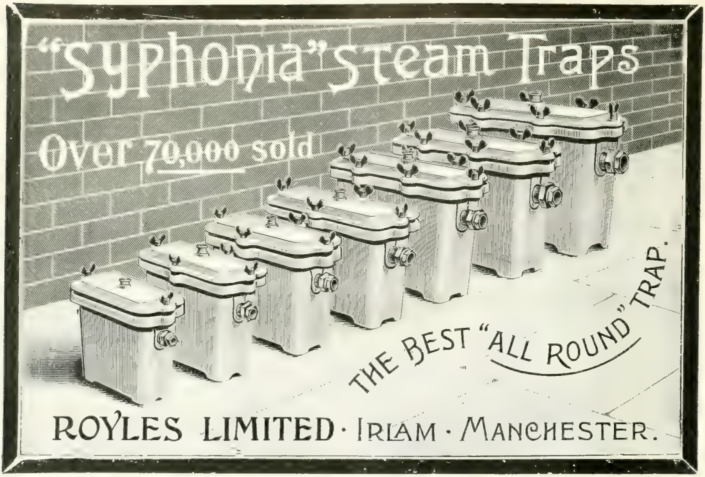

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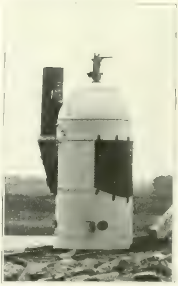

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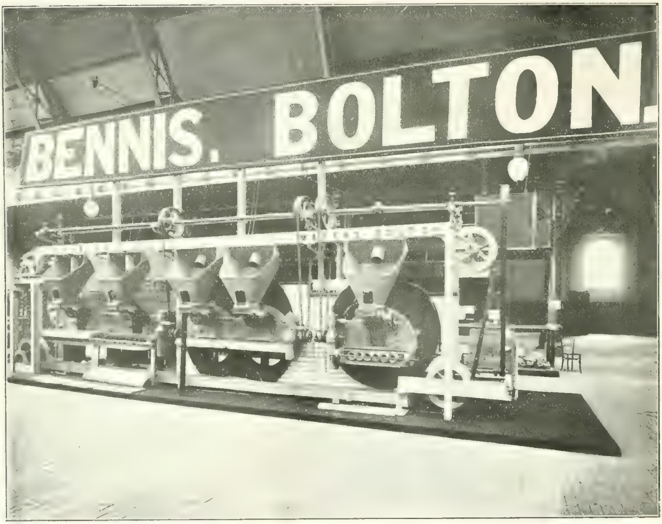

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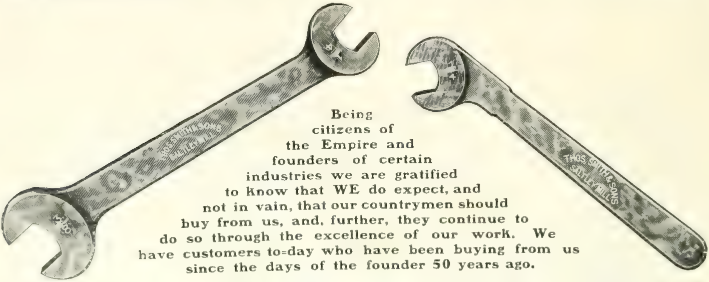

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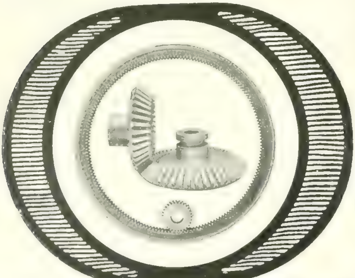

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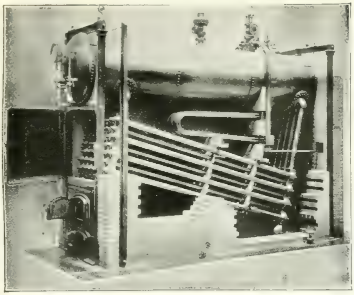

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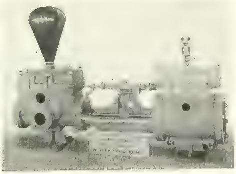

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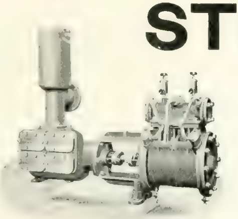

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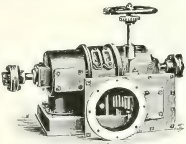

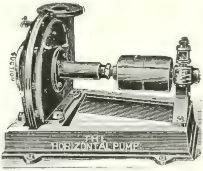

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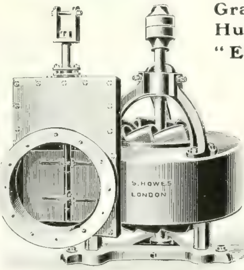

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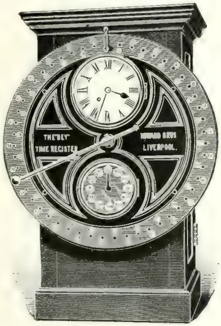

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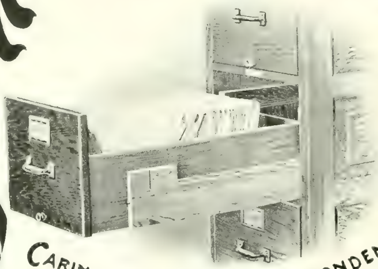

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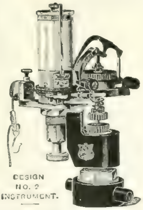

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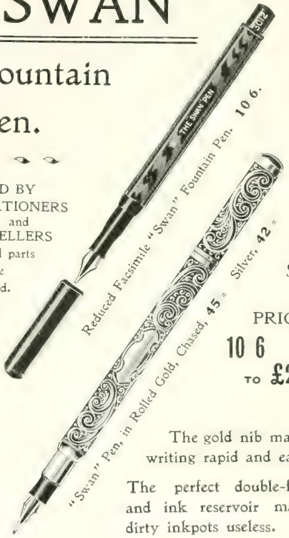

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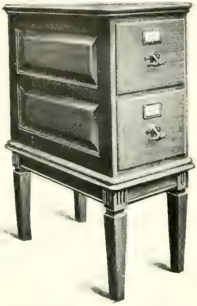

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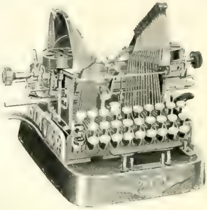

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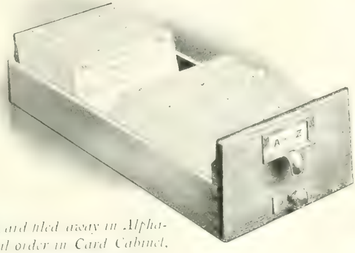

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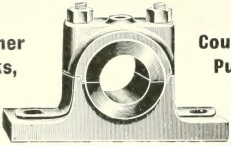

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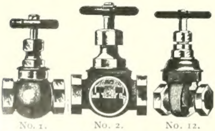
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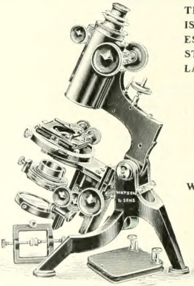

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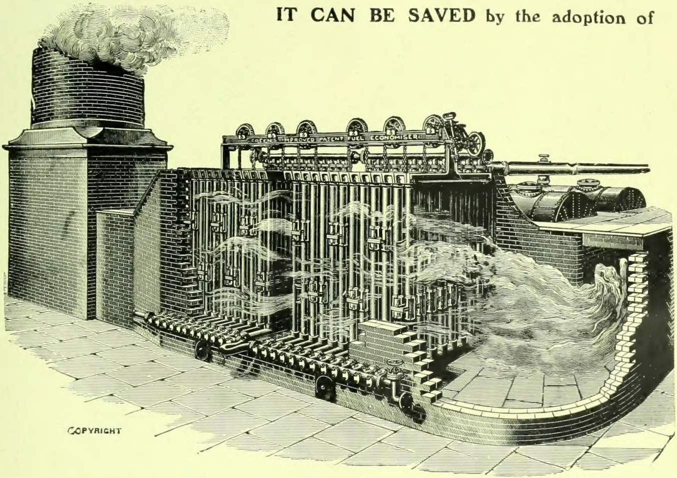
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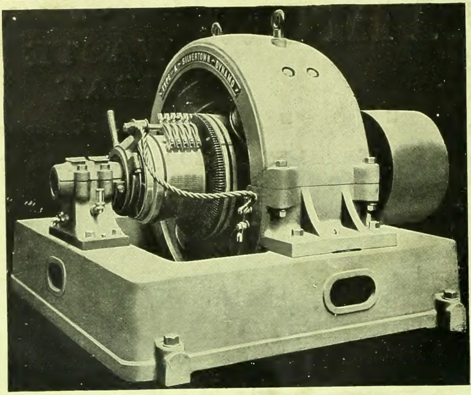

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